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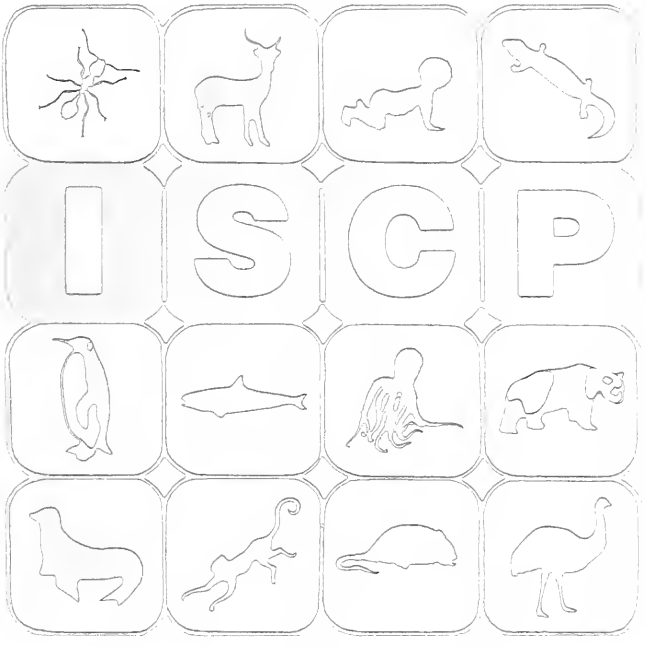

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ON THE NATURE OF EMOTION

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When James (1890) enlarged on his theory of emotion he bemoaned the descriptive nature of psychological works on emotion and wrote "They give one nowhere a central point of view, or a deductive or generative principle." (p. 448 of 1950 Dover reprint). Output of theories after James' publication remained high and continued into the 1930's (see bibliography by Raines, 1929, 1930, 1931; and historical reviews by Gardiner, Metcalf, & Beebe-Center, 1937; and Hillman, 1960). Then, although theories continued to appear, general interest in emotion flagged and in psychology textbooks the subject was relegated to chapters on motivation. Interest revived in the 1970's and is now high again. In a textbook on emotion Strongman (1973) gave vignettes of about thirty of the better known theories all post-dating James. More appeared by 1980 (Plutchik, 1980; Plutchik & Kellerman, 1980; and a bibliography by Rorty, 1980) and this continued unabated in the 80's. Many of these theories are very well known and are examined in the reviews cited. It is neither possible nor necessary to review yet again so many theories if the present one is to be stated, developed and its implications explored. Similarly, the data or phenomena of emotion are too familiar to require detailed presentation here and instead sources of relevant descriptions will be cited. In citing both theoretical and data sources I have tried to use the earliest references since I believe they should be given priority over more recent sources that are essentially saying the same thing but in different terminology or in more elaborate detail. Current sources are given where they are fundamentally or significantly "new."

With so many theories why add another? The very multiplicity of theories suggests that none has a central point of view or a deductive or generative principle that provides a satisfactory or complete explanation of the phenomena of emotion. But what is required of an adequate and satisfactory theory? I suggest it must meet the following requirements.

1. A theory must provide a clear and specific concept of emotion that distinguishes it from other affective states such as hedonic feelings, moods,

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and sentiments. Existing theories too often deal with ill-defined and differing sets of phenomena and seldom make a clear distinction between emotion and these other affective states so that there is little agreement as to the precise usage and meaning of the term emotion. This confusion even led to the denial of the existence of emotion as a conceptual entity, as in such papers as "Is 'Emotion' more than a chapter heading?" (Bentley, 1928) and "An explanation of 'emotional' phenomena without the use of the concept 'emotional.'" (Duffy, 1941).

2. A theory must address all the phenomena of emotion. Historically the phenomena have come to be considered in terms of the following three classes: i) Behaviour, i.e., somatic responses or skeletal muscle actions; ii) Visceral changes, i.e., autonomic responses or smooth muscle and glandular actions; iii) Experience, i.e., conscious mental states of awareness of the behavioural state. Most existing theories of emotion emphasise one or two of these, commonly the visceral changes, in the tradition of the James-Lange theory, and the experience of emotion, as in either the psychoanalytic tradition or the currently popular cognitive processing approach. Few theorists, notably Plutchik (1980), follow the example of Darwin (1872) or McDougall (1936) in emphasising the somatic behaviour.

3. A theory must meet the requirement made of any biological explanation of behaviour (Tinbergen, 1963) of answering the following four classes of question: i) Causation. What is the immediate cause, i.e., what are the physiological, behavioural and cognitive (Sherman, 1988) processes or mechanisms? ii) Function. What is the effect, both immediate and long-term, i.e., what are the physiological, behavioural, cognitive and possible adaptive consequences? iii) Development. How has it come to be like this in the individual, i.e., what are the effects of maturation and experience? iv) Evolution. How has it come to be like this in the species, i.e., what are its evolutionary origins? Few theories of emotion even address all four questions, most concentrating on one or two, commonly causation and function. Plutchik (1980) provides an example of an emotion theory attempting a complete biological explanation and the differences from the present theory will be considered in due course.

In previous articles on the specific topics of attachment, fear, and facial expression (Salzen, 1978, 1979, 1981) I have published the essence of a theory of emotion which I believe can meet all the above requirements. The present article will present the theory in detail and for convenience I shall call it the "thwarted action state signalling" (TASS) theory. A realistic or veridical identification, classification and explanation of the phenomena of emotion should facilitate the recognition of associated brain systems and processes. Some theories of emotion have reversed this process and tried to explain emotion in terms of specific brain systems (e.g., Cannon, 1927; Papez, 1937; Lindsley, 1951; Panksepp, 1982). In doing so they have begged the question as to the nature of emotion.

TABLE 1
Thwarted Action State Signalling Theory of Emotion

Desiderata	*Behaviour*	*Experience*
Phenomena	Thwarted somatic and autonomic actions	Self-perception of thwarted action states
Causation	Thwarting and conflict	Intero- and extero-ceptive feedback of own display
Function	Signalling for social partner to start/stop acting to change thwarting situation	Self-help and self-control made possible by self-perception of signals
Development	Differentiates with motor repertoire and cognitive development	Growth of self-concept, facilitated by speech and language
Evolution	Displays derived from thwarted action states	Speech derived from vocal displays

The implications of TASS theory for identifying the brain systems for emotion are significant but can not be considered here.

THE TASS THEORY OF EMOTION

The theory may be stated as propositions or assertions as follows (Table 1).

1. The phenomena of emotion can be understood as,

a. Incipient somatic actions or intention movements of consummatory acts and their associated appetitive behaviour that have been strongly aroused but cannot be performed, i.e., they are thwarted action states (unpleasant emotion) or are changing from thwarted action states to consummatory behaviour on release from thwarting (pleasant emotion).

b. Visceral changes that accompany and support the somatic actions and especially those that enhance the perceptibility of the somatic actions.

c. Both the somatic and visceral actions have signalling value for social partners and may evolve to form specialised displays.

d. Self-perception by external perception (exteroception) of these somatic and visceral action states integrated with internal perceptions (proprio- and interoception) provides the "awareness" or "experience" of emotion and enables self-signalling and self-responding or self-control. This gives emotional states the potential to act as intervening variables in learning and motivation (Brown & Farber, 1951).

2. The biological explanation of these phenomena is as follows,

a. Causation. The immediate cause is the thwarting of specific strongly motivated actions following arousal, or the subsequent release from such thwarting (for unpleasant and pleasant emotions respectively). Thwarting is defined as the absence of indispensible stimuli or simple physical obstruction following intense arousal, or the simultaneous arousal of two or more incompatible tendencies. Learned anticipation and memories of thwarting or end-of-thwarting circumstances are cognitive causes that may represent the "cognitive appraisal" postulated as the cause of emotion in many cognitive emotion theories.

b. Function. Emotional behaviour serves to signal the nature of the thwarted action state and to induce or "motivate" social partners to change their behaviour in a way that may remove thwarting. Emotional behaviour on release of thwarting serves to signal the success of the helping behaviour and switch to consummatory interactions and states and so may become reinforcing or "rewarding" to the social partner. Self-perception enables the individual to respond in a helping (coping) way to its own thwarted action states and circumstances as it might to the emotional displays of others. This is the "self-motivating" effect commonly regarded as the prime function of emotion. Similarly self-perception of end-of-thwarting states can lead to the commonly accepted "self-reinforcing" or rewarding effect of pleasant emotional states.

c. Development. Emotional behaviour will differentiate as specific appetitive and consummatory behaviours develop and differentiate. Perception of emotional displays and their associated circumstances in others enables the development of empathy. Self-perception of one's own displays and especially vocalizations as comparable with others leads to self-signalling and contributes to the development of self-awareness, self-control and sympathy. Speech development completes the process.

d. Evolution. Intention movements convey information as to the nature of the aroused behaviour and have been selected for their signalling values; so, too, have associated visceral changes that can be detected by social partners. They may become "ritualized" to form special displays as seen in agonistic, sexual, parental, infantile, and alarm displays and ceremonies. Social responses and helping behaviour that facilitate these interactions have been correspondingly selected with these signals. Vocalizations produced by these visceral and somatic actions are part of this signalling and at moderate levels of arousal could provide the basis for modulation and evolution into speech.

A definition or concept of emotion. An explicit definition of the term emotion must be consistent with any satisfactory theory since such a theory, by being totally descriptive of the phenomena and their properties, is itself an implicit definition. That is not to say that it must either reject or coincide with current usage, but rather that it should refine the

meaning of the term so as to decrease ambiguity and increase precision of application and usage, both in relation to the real world and in relation to other terms and concepts.

Historically, the term emotion derives from the Latin e-movere meaning "to move from" or "to disturb." It was originally used in the sense of migration of people and then for movements of the ground or earthquakes. In 16th century English, it was used for the agitation and tumult of social upheaval, as in "public emotions." By the 19th century, it had come to mean a disturbance of the mind or "affective upheaval" and finally a "tumult of feeling" (Young, 1943, p. 25). I agree, therefore, with Young (1961, p. 353) in his statement that "An emotion is a variety of affective process distinguished from the others as an acute (brief and intense) affective disturbance." TASS theory is consistent with this usage of the term. However, in addition it specifies the causes and nature of the disturbance in terms of response processes.

A preliminary definition of emotion based on TASS theory would be: emotions are the behavioural, visceral and mental states that occur when activated motivated behaviours are thwarted or in conflict. However thwarting can account only for the disturbances that we experience as unpleasant. In order to account for displays of pleasure and happiness, the decline of the responses to thwarting and the change into consummatory behaviour at the release from thwarting or the resolution of conflict must be included in the definition. Thus a concise definition of emotion would be: emotions are the behavioural, visceral and mental states that occur when activated motivated behaviours are thwarted or in conflict or when they are released from this thwarting or conflict. This definition allows us to distinguish emotion from other affective states which include hedonic feelings, moods, and sentiments. They can be broadly defined and distinguished as shown in Table 2.

In summary, I suggest that *Affect* be the generic term for the arousal and experience of motivational action states; that *Feelings* refer to ongoing activated behavioural states; that *Moods* refer to unactivated motivational responsive states; that *Emotions* refer to blocked activated behavioural states; and that *Sentiments* refer to cognitive constructs of feelings, moods, and emotions (McDougall, 1936).

THE TASS ANALYSIS OF EMOTIONAL BEHAVIOUR

This analysis arises from the view that if we wish to understand the essential nature of emotion we must use the comparative approach and examine the equivalent phenomena in related vertebrate animals. Human emotion must have evolved by modification of behavioural systems common to our fellow primates and be present, in more basic forms, in homoiothermic amniotes, i.e., birds and mammals, and possibly even in all vertebrates. The behavioural phenomena comparable with human

TABLE 2
Terminology of Affect

Affect.

From the Latin *affectus* meaning "disposition." A generic term applicable to the activation and experience of motivational states.

Feelings (hedonic).

Sensori-motor states of beneception or nociception and appetite or aversion associated with the activation, performance, and consummation of motivated behaviour, e.g., of tasting, of being hungry, of eating, of being sated.

Moods.

Enduring metabolic and hormonal motivational states operating through both general (e.g., mania and depression) and specific (e.g., parental, sexual) activation systems.

Emotions.

Acute feeling and action states associated with the thwarting or end-of-thwarting of activated motivated behaviour, e.g., anger, fear, joy. Chronic emotional states result from reminiscence or anticipation of thwarting or end-of-thwarting (e.g., anxiety and hope, love and hate).

Sentiments.

Cognitive constructs and attitudes of an affective content based on past experience of feelings, emotions, and moods, e.g., patriotic, religious, moral and aesthetic attitudes and beliefs.

emotional behaviour are recognised even by the layman as the displays given by birds and mammals in escape and flight, in aggression, in courtship and mating, in parenting, and in affiliation. These displays have been well analysed by ethologists who have shown that a wide range of such "expressive" patterns can be understood as intention movements and postures (Daanje, 1951), or combinations of such elements, belonging to actions that are blocked or prevented from completion either by inadequate and inappropriate stimulus circumstances or by conflict between incompatible aroused action tendencies (Baerends, 1975; Eibl-Eibesfeldt, 1975; Hinde, 1970; Smith, 1977; Tinbergen, 1958). This analysis of social signalling in vertebrate animals up to and including primates and humans is firmly based on comparative studies of behaviour and is not in any way dependent on classical ethological motivation theories or analogies (Hinde, 1985).

In an article on the origin of social signals Morris (1956) gave a summary analysis of this social signalling and of its relation to thwarting and conflict. This analysis, with some amendments, is shown in Table 3 as a

TABLE 3
Thwarting and Responses to Thwarting

	Thwarting Situations
I	Absence of indispensible stimuli following intense arousal
II	Simple physical obstruction of aroused activity
III	Simultaneous arousal of two or more incompatible tendencies
	Primary Responses to Thwarting
Somatic	
1	Perseverance—persistent approach and adjustment (I, II)
2	Snap Decision—capricious choice of response (III)
3	Threshold Intention Movements—initial element of response (I, II)
4	Ambivalent Posturing—elements of both responses (III)
5	Alternating Intention Movements—successive initial responses (III)
Autonomic	
1	Alimentary—salivation increase or decrease, urination, defaecation
2	Circulatory—pallor, flushing, genital vasodilation, fainting
3	Respiratory—changes in rate and amplitude, panting, gasps, sighs
4	Thermoregulatory—sweating, feather/hair raising/sleeking
5	Lacrimatory—weeping
	Secondary Responses to Thwarting
1	Displacement Activities—irrelevant behaviour
2	Redirection Activities—response to another stimulus
3	Regressive Activities—immature responses
4	Neurotic Inactivity—loss of responsiveness
5	Aggressive Behaviour—intense approach and adjustment
6	Stereotypic Activities—repetitive movement patterns
7	Visceral Dysfunction—chronic autonomic imbalances

summary of the elements of emotional behaviour according to TASS theory. Thwarting and conflict are clearly defined and the types of somatic motor actions and of visceral actions that form the primary response patterns are presented. In addition, there is a list of secondary

responses to thwarting that Morris suggested could result if the primary responses failed to lead to the end of thwarting. I have added three items, *aggressive behaviour, stereotypic activities,* and *visceral dysfunction* to the original list given by Morris. Some explanatory notes on the scheme in Table 3 follow.

i) Primary somatic responses. The motor responses to thwarting are essentially the incipient actions of the aroused specific motivated behaviours such as attack, flight, mating, parenting, etc.

In *Perseverance* the activated behaviour is persistently attempted in increasingly intensified form. At lower intensities persistent appetitive actions are interpreted as "interest" and it is not insignificant to note that some theorists include interest as a primary category of emotion (Izard, 1971; Ekman, Friesen, & Ellsworth, 1972). Perseverance involves orientative readjustments in approach behaviour which may remove the thwarting. Clearly it is this type of response that can result in learning, as in trial and error learning. This could account for the common notion that emotional arousal is necessary for learning to occur and that it is emotion that motivates, and the reduction in emotional arousal that reinforces, the learning. TASS theory says that the arousal is of underlying motivational action states and that thwarting provides the necessity and opportunity for the variation in appetitive behaviour that in turn may lead to the consummatory stimulus and act. Thus, emotion may provide the medium for learning but is not the instigating factor. At higher intensity persistent approach responses may be interpreted as "desire" or "love." This is an emotion that is strangely absent in many classifications of the basic emotions but was recognised perhaps by McDougall (1936) as "tender emotion" and by Plutchik (1980) as "acceptance." At high intensity, approach and orientation responses may result in attempts to adjust the position of the object (reorientation) even to the extent of causing its disappearance or destruction. For example, aggression in mating behaviour may derive from excessive actions for copulatory orientation. Such behaviour is seen as emotional or frustrative "aggression" and is consistent with the frustration aggression theory of Dollard et al. (1939). In *Snap decision* performance occurs after some delay but in an unpredictable and irrational way. It is the flustered "emotional" decision.

The remaining types of primary somatic response to thwarting shown in Table 3 are halted initial actions or *intention movements* of the activated behaviour alone (*Threshold intention movements*), in combination (*Ambivalent posturing*), or in succession (*Alternating intention movements*). They are coupled with appetitive orientation movements and postures that are directed toward or away from the stimulus source. Because these movements indicate the nature and direction of the intended or activated behaviour they have signal value that can be selected, enhanced and "ritualized" (Blest, 1961; Huxley, 1914; Tinbergen, 1952)

in evolution. This will occur especially where the response to thwarting induces behaviour in a social partner that removes the source of thwarting. Thus, if the social partner has been behaving inappropriately or ambivalently it may be induced to change to actions that are more appropriate for the aroused but thwarted individual. This type of interaction can explain the evolution of courtship ceremonies, agonistic displays, and parent-offspring affiliative interactions (Eibl-Eibesfeldt, 1975; Hinde, 1970). This social signalling of thwarting is not confined to dyadic interactions. Where thwarting is due to a circumstance, either organismic (e.g., a third species member or another species) or environmental (e.g., physical obstruction), that a social partner can affect by a change of behaviour then responses to thwarting may also evolve to give displays such as alarm, fear, and distress displays, that produce helping behaviour, mobbing, and other cooperative behaviour. A similar selection of responses to thwarting that deter, hinder, or otherwise affect the behaviour of potential predators may lead to the evolution of intra-specific fright and defensive displays, including distraction displays, e.g., the broken wing display of birds such as the killdeer (Deane, 1944; Simmons, 1955). Thus TASS theory applies to "emotional" displays specific not only to social partners, physical objects and circumstances, but also to other species. In all cases the effect is to change the situation by inducing behavioural changes in other organisms so that the original aroused consummatory actions may be performed.

ii) Primary autonomic responses. Table 3 shows the autonomic (visceral) system activities that may occur in primary responses to thwarting. They are essentially the visceral actions that accompany the activated behaviour and the enhanced activities of the appetitive orienting behaviour. Morris has classified them by system, and emphasised those changes that are perceptible (i.e., visible, audible, or olfactory) to the social partner (or other organism) and so serve as signals that could be selected and evolve into distinctive displays. Normally somatic and visceral displays are coupled so that the motor action maximizes the detectability of the visceral display as in "waving the flag." Perhaps it would be more accurate to say "flagging the wave" in that the visceral actions become exaggerated in regions of the somatic motor action that they make more perceptible and where they emphasise the movement. In either event this coupling produces the familiar avian and mammalian emotional feather, hair, and bare swollen skin displays, and scent deposition. Irregular respiratory responses to thwarting are shaped by the bodily movements of specific primary somatic responses and produce specific vocalizations. This has led to two significant developments. First, because signalling vocalizations are perceived by the signaller in almost the same form as those given by social partners there is the possibility of responding to one's own vocalizations as if to another social partner, i.e., to self-signalling, self-awareness, and self-control of emotions. Sec-

ond, modulated thwarting vocalizations at moderate levels of activation form an ideal substrate for the evolution of speech.

A deduction or prediction from TASS theory is that we would not expect covert imperceptible autonomic responses to be distinctive for specific somatic response states, i.e., to be specific to particular emotions. And, indeed, generations of psychophysiologists have failed in the search for specific visceral patterning in the emotions. Winton, Putnam, and Krauss (1984) in an excellent study showed a correlation between heart rate and pleasantness and between skin conductance and arousal. They suggest that visceral information reflects the dimensions underlying affects rather than the classes of affects. Even in the sophisticated studies of Ekman, Levenson, and Friesen (1983) the claimed degree of specificity using heart rate and temperature is poor and only separates groups of the common emotion categories. Psychophysiology has been chasing a "will o' the wisp" and such study is warranted only for sub-threshold affective action detection, i.e., to detect activation states that are insufficient to produce perceptible overt motor actions. In this case, EMG measures would still be the sensible approach, since they are the means of detecting the sub-threshold primary somatic responses that are the specific action states of emotion (Cacioppo & Petty, 1981). In this respect work such as that of Schwartz and co-workers (Schwartz, 1982) is clearly more fruitful. In a sense the psychology of the emotions was thrown off course by James and Lange who unlike Darwin emphasised the visceral responses, probably because these seemed to be the key to the experience of emotion. Subsequently few people paid attention to McDougall's attempt to reinstate the primacy of motivated behaviour in emotion.

Elsewhere (Salzen, 1978), on the basis of chick and primate data, I have noted that autonomic responses to thwarting are predominantly of the sympathetic nervous and glandular systems and that end-of-thwarting is characterised by a swing from sympathetic to the parasympathetic dominance characteristic of consummatory actions and stimulation. This is consistent with the ideas of Gellhorn (1957, 1966) on sympathetic/parasympathetic balance and rebound phenomena in his hypothalamic theory of emotion. I would suggest that the more recent Solomon and Corbit (1974) opponent process theory of motivation is dealing with the same phenomena, i.e., thwarting and release from thwarting, and the associated sympathetic/parasympathetic discharges, and with the well known physiological phenomena of rebound that Gellhorn has exploited to considerable effect.

iii) Secondary responses to thwarting. These are the responses, both somatic and visceral, that may replace the primary responses if thwarting is persistent and unrelieved. Table 3 lists the classes of response. What is significant about all these secondary responses to thwarting is that they have the appearance of pathological behaviour and are the stuff of psychiatry. Furthermore they have lost the intention movement elements

of the activated but thwarted motivation and/or the goal stimulus orientation and so have lost their specific signalling values. This is what makes their psychiatric diagnosis so difficult; the existence of thwarting or conflict is evident but its precise nature is not, even to the patient. Yet, as will be indicated, secondary responses to thwarting may still have either some signalling value or some other adaptive value and if so may have been selected for in evolution. The first four derive from Morris's analysis and need little explanation.

1. *Displacement activities* (Armstrong, 1947, 1950) include behaviour such as eating, drinking, and grooming inappropriate to the situation; all are well described in conflict situations in the ethological literature and reported in humans (Eibl-Eibesfeldt, 1971). They may act by redirecting the attention and/or switching the motivation of the social partner in a way that makes further social interaction more likely. They may also form the basis of evolutionarily specialized agonistic and courtship displays, as suggested by Schenkel (1958) in discussing the origin of the peacock display from displacement feeding.

2. *Redirection activities* of attack, sexual, and parental behaviour to alternative stimuli when responding to the appropriate stimulus is not possible occur in animals and humans (Eibl-Eibesfeldt, 1975). Redirection is a discharge of primary responses that at least warns others of the individual's state and allows both the individual and the group to resume other ongoing activities.

3. *Regressive activities* include infantile food begging in courtship in birds and mammals, suckling behaviour in distress in mammals, loss of sphincter control in fear in mammals, and infantile temper tantrums in thwarted desires in primates. All occur in humans. Regressive behaviour tends to elicit parenting and caring responses from the social partner and helping responses from the group.

4. *Neurotic inactivity* is a Morris innovation and may correspond with the flaccid condition that can develop after prolonged tense states typical of fearful freezing and immobility responses (Ratner, 1975). It can lead into sleep. Sleep can occur in conflict states in animals and humans when it can be classed as a displacement activity (Armstrong, 1947). Delius (1967) has suggested that displacement sleep might result from an "overshoot" (rebound?) in arousal regulation and this could be the basis of neurotic inactivity. Neurotic apathy and depression can occur in chronic separation in monkeys and humans (Kaufman & Rosenblum, 1967a,b; Scott & Senay, 1973; Bowlby, 1969, 1973). Neurotic inactivity can be the least damaging response for the individual where alternatives are equally disadvantageous. In chronic separation in infants it can be energy conserving (Kaufman & Rosenblum, 1967b). In fear responses, freezing and immobility can lessen detectability to a predator or even serve as a false signal, e.g., death feigning (Ratner, 1975).

5. *Aggressive behaviour* is my first addition to the list of possible

secondary responses to thwarting because it could be a specially evolved secondary response to thwarting derived as already described from the primary somatic response of *Perseverance,* i.e., enhanced approach and orientation responses to the arousing but thwarting stimulus object. Offensive aggression and fighting behaviour employing species patterns of fighting such as biting, striking, and stomping in apes and humans may represent a specially evolved motivational action system (agonistic behaviour for social and reproductive advantage and possibly predatory aggression in hunting). This would support the distinction between agonistic fighting and frustration aggression (Moyer, 1976). The question then is to what extent agonistic fighting has become independent of thwarting and is intrinsically motivated or autochthonous (Lorenz, 1966). This is a subject that is of wide concern for humans (Hinde, 1967). If offensive aggression is autochthonous, then full confident attack may be unemotional, i.e, it can occur without thwarting, and be carried out quite "coolly" while threat behaviour in the form of intention movements is the "heated" emotional display resulting from thwarting of the attack.

6. *Stereotypic activities* is the second of my additions. It, too, could be derived from *Perseverance* with a breakdown of repeated appetitive orientation behaviour into fragmented motor elements. This would result in repeated but apparently aimless sequences of locomotory movements. Similarly, motor actions such as scratching, rubbing, grooming, and biting directed to body parts could be a combination of *Stereotypy* with *Displacement activity* or (in the case of biting) with *Redirection.* Stereotypies do seem to be a breakdown in behaviour and are probably only seen in extreme circumstances as in captive animals and human pathology. But stereotypic movement involving constancy of form and repetition of action is an important element in ritualized thwarting displays where it serves the function of signalling the intensity of the aroused action state (Morris, 1957).

7. *Visceral dysfunction.* If thwarting and conflict persist then visceral responses to thwarting will become chronic and the same fragmentation may occur as in the case of stereotypies. These autonomic or visceral dysfunctions are the kinds of response syndromes familiar in stress conditions and in psychosomatic disorders. Perhaps we can say that secondary somatic responses are evident in humans with neurotic complaints while secondary visceral responses are present in psychosomatic disorders. Visceral dysfunction parallels stereotypy in being a breakdown in function and representing pathology. But the enhancement of a specific visceral response, often in a particular location which may well be associated with a repeated and stereotyped movement, is a common feature of ritualized displays (Morris, 1956).

iv) End-of-thwarting displays. On release from thwarting and conflict there is a changeover in behaviour in which the responses to thwarting are declining rapidly and being replaced by consummatory behaviour

and the achievement of a consummatory state. This changeover presents a distinctive pattern of behaviour and internal state that is associated with the events or situation that end the thwarting. This transitional behaviour, too, can be selected and developed in evolution to produce distinctive relief or "pleasure" signals, characterized by relaxation of the tension of the responses to thwarting, and specified or "flavoured" by the nature of the ensuing consummatory stimulation and response state. Such signals would indicate both the appropriateness of the social partner's present behaviour in response to the thwarted response display and the onset of consummatory behaviour that may require a corresponding change in this behaviour to continue or end the ongoing interaction sequence.

Andrew (1963) has described an intensity continuum in the character of vocalizations that primates give from low intensity social greeting, contact, and food recognition calls, to high intensity social isolation calls, and "distress" calls given to high stimulus novelty. He noted that there is a basic similarity in monkey, chimpanzee and human infant distress cries with sound spectrograms that have the same basic features, i.e., a vigorous attack, higher pitch composition of long duration and descending tail (see also Wolff, 1969, for human neonate cries). In contrast, their social contact and food recognition calls consist of a brief rise and fall, and are of lower pitch composition. In short, there is cross species evidence that lends credibility to the notion that vocalizations due to decreasing responses to thwarting with declining sympathetic activity occurring at the onset of consummatory behaviour with its parasympathetic dominance may be "seen" or interpreted as "pleasure" calls. Of course, this does not mean that all collapsing thwarting states are interpreted as, or give rise to, pleasure displays. For example, such a relationship might seem unlikely in the case of threat vocalizations. Yet, in rhesus monkeys, Rowell and Hinde (1962) describe, in addition to a threat bark and a less confident growl, "friendly" noises that included a food bark of lower pitch than the ordinary bark, a similar bark given in greeting, and a long growl made up of short elements that was in some cases used in grooming invitations and had some similarity to the "pleasure" or girning sounds that occurred mixed with growls in affiliative and contented animals. There is perhaps the suggestion that an initial arousal of threat or scared-threat quickly relaxes so that there is an indication of a relaxing state that is at least reassuring if not pleasing to the social partner. Relaxing fear and distress displays may be more likely to become distinctive "pleasure" displays where quiescence follows removal of the provoking stimulus, whereas other thwarted states give place to the performance of the hitherto thwarted behaviour which itself is the informative social signal. It should be recalled that smiling and laughter, the prime displays of happiness and joy in humans, may also be derived from

the relaxation of a basic primate protective grimace and of an open-mouth bared-teeth scared threat display respectively (van Hooff, 1962).

According to TASS theory, then, pleasant emotions should be short-lived, relief and relaxation responses and quickly give way to consummatory behaviour or quiescence. This is true of "joy" and "delight," while more prolonged euphoric states can be produced by reminiscence or by anticipation of end-of-thwarting. Furthermore, the theory predicts that the intensity of joy/pleasure will be low if there is no delay or anticipated delay between arousal and gratification of a consummatory act because there will be no thwarted action display to subside. Presenting and then withholding the arousing stimulus will increase this display and hence the changeover at the end-of-thwarting, i.e., the pleasure, will be greater the higher the level of the aroused action tendency because there will be a greater changeover in the somatic and visceral patterns. These are the phenomena involved in teasing, sexual foreplay, and perhaps in the use (both real and metaphorical) of *hors d'oeuvres*. The pleasure will be less the slower the release from thwarting because the rate of changeover will be lower and the display and internal perceptions less intense. If thwarting is prolonged the thwarted action state behaviour may first intensify but ultimately may decline or fatigue. This initial facilitatory effect and subsequent adaptation or fatiguing effect of the performance or attempted performance of motivated behaviour is known but the physiological explanation is in dispute. Whatever the cause, the result is that moderate delay of gratification gives a greater changeover or end-of-thwarting state or "pleasure" while too long a delay with its consequent decline in thwarted action states can then only produce a weak display—the phenomenon of the "let-down" of a too long awaited desire. If release from thwarting is unexpectedly quick and the levels of activation and behaviour are high, then there may be a residual discharge of the thwarted state behaviour before relaxation occurs; this is the redirected attack of the "air-punch" and "shout" in humans or the "trumpet" of geese triumph displays (Eibl-Eibesfeldt, 1975; Fischer, 1965). Triumph displays are a nice example of the possible signal value of end-of-thwarting displays; they can signal to the social group the identity of the successful individual and, in the case of group or team actions, they ensure that team effort is not continued unnecessarily and everyone can relax.

The switch from responding to a partner's thwarted state behaviour to resuming interrupted ongoing sequences or relaxed states is signalled by the end-of-thwarting displays. These displays, therefore, can serve as conditioned or secondary reinforcers and incentive stimuli for the helping responses which have produced the end-of-thwarting. This is an effect of smiling in social interactions, for example. A similar learning effect in the signaller means that the end-of-thwarting state can become the secondary goal of the appetitive behaviour arising from thwarting. There is

a common impression that we strive for happiness and joy rather than for the consummatory behaviour and states themselves. This is not so, and the philosopher Ryle (1949) has made a similar point in respect of pleasurable activities in humans. In fact, there are abnormal conditions in which this may be the case. For example the Don Juan is more concerned with, and gets more pleasure from, his conquests, i.e., the success of his seductive behaviour than the ultimate coital act. Similarly, the miser is more concerned with his money than with the bodily satisfactions it can bring. But for most people secondary reinforcers ultimately fade and extinguish unless accompanied by biological consummation, so that "money alone does not bring happiness." It is possible that the reinforcing and incentive effect of end-of-thwarting is operating in coping behaviour and in competence motivation (White, 1959). The achievement of competence or coping with the environment may be a key feature of childhood play (tickling, peek-a-boo, catch-me) and many adult games of skill. Again, individuals can become trapped with the secondary reinforcement of the end-of-thwarting even to the extent of risking life and limb in mountaineering and similar dangerous but biologically pointless pursuits.

THE APPLICATION OF TASS THEORY

The following two brief accounts show how TASS theory can be used to analyse complexes of emotional behaviour.

i) Attachment, separation and reunion. I first applied a TASS analysis to the behaviour seen in social attachment in nonhuman primates and humans (Salzen, 1978). On the basis of a neuronal modelling theory of imprinting (Salzen, 1962, 1970), I treated attachment behaviour as a sensory homeostatic response pattern which serves to maintain contact or the close presence of the familiar attachment object, somewhat in the manner of the goal-steered model used by Bowlby (1969). Separation represents a disturbance of this state and there is appetitive orientation behaviour to restore the object presence. This behaviour becomes emotional when restoration is blocked and the thwarted responses of persistent and enhanced seeking and approaching occur (primary somatic responses of *perseverance*). They are accompanied by distress vocalizations (a primary visceral *respiratory* response to thwarting). This is the pattern of "separation protest" (Bowlby, 1969, 1973).

In older children learned anticipation of chronic separation (Bowlby's "working models of the mother") might be expected to give responses to anticipated thwarting in the form of persistent approach and clinging (*perseverance*) or at least "glancing looks" (*intention movements* of approach) even in the presence of the mother, and this corresponds with Bowlby's "anxious attachment." If separation continues despite the primary orienting responses to thwarting, then secondary responses to thwarting develop. These include "temper tantrums" in the form of

TABLE 4
Facial Actions, Motivational Action States, and Emotions

Motivational Action State	*Description of Facial Actions*	*Emotional States*
Attention	Focal stare, slight frown and mouth tension. Head forward.	Interest, curiosity.
	Phasic, open eyes and mouth, raise eyebrows, head back, gasp.	Surprise, astonishment wonder, awe.
Appetence	Lip and tongue protrude, open mouth and attention for oral intake.	Desire, want, longing, love, devotion.
Aggression	Attention with tight or open mouth of intention bite and shout.	Anger, annoyance, hate, fury, rage.
Rejection	Dilate nostril, raise upper and evert lower lip, depress mouth corners with eject action of tongue. Avert head. Lacrimation.	Disgust, disdain, dislike, contempt. Weeping, crying.
Aversion	Eye aversion, head turning and abduction. Eyes close (cut-off), hide. May be initial attention.	Fear, horror, panic, terror, dread.
Protection/ Effort	Close eyes, clench teeth, retract lips (grimace) and hold breath or grunt/scream.	Distress, anguish, suffering, tension.
Fatigue	Eyelid droop, jaw drop, open mouth for inhalation. Residual effort in oblique brow and clenched teeth.	Sadness, grief, despair, dejection, despondency.

TABLE 4
Continued

Motivational Action State	*Description of Facial Actions*	*Emotional States*
Acceptance/ Relief	Relaxation of other facial actions. Smiling from protection grimace. Laughing from open-mouth scream of attack/ protect or surprise.	Happiness, joy, delight, elation, ecstasy, bliss.

neonatal undifferentiated repeated extensor movements (*regression*) and thumb sucking (*displacement feeding*), self-rocking (*stereotypy*), and striking others (*aggression*). Subsequently, there may be clinging to a toy or other familiar object providing contact, and this may alternate with rejection of, and aggression towards, the object. Or there may be self-clinging and contacting. The objects are substitutes that provide contact stimulation and to which approach and consummatory clinging behaviours are redirected (*redirection*). There may also be loss of sphincter control (*regression*). Finally "despair" behaviour in the form of apathy and inactivity may set in representing secondary responses to persistent thwarting (*neurotic inactivity*).

The behaviour at "reunion" is normally like that of "anxious attachment," i.e., an enhancement of appetitive approach and consummatory contact responses, although of limited duration. But if the child has become "detached" (Bowlby, 1969, 1973) it may show a blank stare, turning away, distress crying, or apathy, alternating with approach and clinging. The approach may also be aggressive. It is as though the attachment figure is reactivating the attachment behaviour of approach and clinging but also the responses to thwarting that became associated with memory of the attachment figure durding the chronic separation period. In any event this is clearly an example of *alternating intention movements* as a primary response to thwarting and *aggression* as a secondary response to thwarting resulting from a conflict state. The original account (Salzen, 1978) of this analysis of attachment behaviour in nonhuman primates and humans should be consulted for a full assessment of the potential of TASS theory and for a full literature review.

ii) Facial expression of emotion. In an application of TASS theory to the analysis of human facial expressions of emotion (Salzen, 1981) I identified eight possible classes of action pattern (Table 4) that seemed to encompass the descriptions of facial expressions of human and non-

human primates available in the literature. These actions were then looked for in the still photographs of the Froois-Wittman series of facial expressions for which corresponding emotion judgments were available (Hulin & Katz, 1935). These eight action patterns appeared to form the predominant elements of eight types of facial expression that are commonly assigned to eight fundamental categories of emotion (also shown in Table 4). An empirical study (Salzen, Kostek, & Beavan, 1986) of the perception by adults and children of these basic action classes and emotion classes in two series of still photographs gave some confirmation of this correspondence, especially for the children. A study by Kirouac, Bouchard, and St-Pierre (1986) did not find a good correspondence between the recognition of classes of behaviour and emotion but their categories differed significantly from those in Table 4 and they did not test children. Tests with video-recordings should prove more interesting because the actions will be more evident. Some of the ambiguities in identifying responses to thwarting or emotional states in photographs of faces lie in the absence of information as to the whole body orientation movements and also in the absence of vocalizations. The significance of whole body orientation and the nature of the eliciting stimuli will be made clear in the next section.

Some supplementary comments especially with respect to vocalizations may be helpful in appreciating Table 4 although the full descriptions and review of relevant literature in the original papers will need to be read.

In the case of *Attention* (Table 4) it is arguable whether interest and surprise are "really" emotions or simply the precursors to emotions once the source of novelty has been identified. Both attentive behaviours can serve as social signals of an interrupted action state and so are included in the present emotion concept. I suggest that the full phasic surprise response is an alarm reaction, because it is normally accompanied by a scream or at the very least an unvoiced gasp, and seems to have many of the characteristics of alarm calls in other primates. Sustained attention (interest) can be an affectively neutral cognitive state but also forms part of most motivated action patterns.

Appetence, with its associated emotional state of want, need or desire, is distinguished in Table 4 from attention although it usually involves sustained attention. In an empirical study of recognition of face photographs with free labelling (Salzen, Kostek, & Beavan, 1986) people used the category of interest for both attention and appetence expressions. In common usage, interest is often a euphemism for want or desire, perhaps because intense attention is almost invariably part of appetence behaviour.

Thwarted attack or *Aggression* (Table 4) involves not only threat postures and expressions but also the low pitched voiced expiration of the angry shout. This may rise in pitch content as it merges with the

scream of the protection/effort state to form an ambivalent open-mouth scream or scared threat display (van Hooff, 1962).

In the case of *Rejection* (Table 4) the typical disgust pattern may give place to crying (weeping), and the incipient cry face is very similar to an incipient disgust expression. This cry face and crying may be a ritualized infantile care-soliciting signal evolved from rejection responses. It can easily merge with open-mouth screaming when the rejection responses are without effect and mixed protective/effort and aggressive responses are recruited.

In *Aversion,* in addition to the thwarted intention movements of withdrawal described in Table 4, there may be tension and screams characteristic of the protective response given in anticipation of contact with the aversive stimulus. The social communication of fear occurs either through the incidental signalling, i.e., through seeing the actual non-thwarted withdrawal responses of a social partner, or through the thwarted state signalling of the alarm and protective vocalizations (see Morris, 1956 for the distinction between signalling in non-thwarting and thwarting situations). There may not have been selection for a specific facial expression of fear, for we do not normally look at our social partner's face in order to learn of the existence of environmental dangers (although we may look to see the direction of their attention and hence the locus of danger). In fact the recognition of "fear" faces in photographs is poor and they are often confused with surprise, anger or distress.

In the *Protection/Effort* display described in Table 4 the accompanying vocalization is distress screaming which can signal for parental and social help. The protect face is similar to the startle expression described by Landis and Hunt (1939). The startle response is a phasic reflex which may be quickly followed by orienting, protective and flight responses. Strauss (1929) called these "secondary responses" and it is these that may be said to be "emotional." This, perhaps, answers the question "Is the startle reaction an emotion?" raised by Ekman, Friesen, and Simons (1985). As in the case of flight a successful protective response need not be "emotional" but may become so when it fails to protect. The adjustive actions and vocalizations to remove the stimulus represent responses to thwarting and constitute distress displays that are "emotional."

In *Fatigue* or exhaustion the actions and vocalizations are the residual elements, or recurrences, of the specific responses that have been chronically thwarted. Thus in grief and mourning there may be residual or recurrent rejection responses of crying and weeping, i.e., in rejection of the unwanted noxious knowledge or thought of the loss of the loved object.

In the case of *Acceptance/Relief* (Table 4) the facial expressions of smiling and laughing are probably ritualized relief/relaxation responses. Smiling or the "grin face" can be understood as the relaxation of an

incipient protect or scream face. Laughing or the "play face" can be understood as oscillatory relaxations of the scared-threat or open-mouth scream face, itself an ambivalent posture combining open-mouth threat and scream face (van Hooff, 1962; Salzen, 1981). A case could be also be made for laughter as relaxation oscillations of the alarm reaction, surprise, which it often follows.

In conclusion, it is possible to analyse facial expressions of emotion in terms of eight classes of action pattern interacting with the degree of arousal and the presence of thwarting. Dyadic and higher combinations of these action patterns could account for a wide range of "mixed" or "blended" emotional expressions. Table 5 illustrates possible emotional interpretations of dyads of the eight action patterns. This analysis will now be compared with the traditional analyses of facial expression which have been used to examine the nature of emotion.

CATEGORIES, DIMENSIONS, AND THEORIES OF EMOTION

It is clear from a number of reviews (Izard, 1971, 1977; Dittman, 1972; Ekman, Friesen, & Ellsworth, 1972; Salzen, 1981) that studies of facial expression of emotion result in two different inferences about the nature of emotion. In one type of study the data seem to show that there are a number of discrete classes of expression which correspond with subjective and traditionally recognised discrete emotional states or categories of emotion. In the other type of study the data suggest that there are a limited number of inferred underlying states or dimensions of emotion rather than discrete categories.

The "category" approach has been critically reviewed by Ekman, Friesen, and Ellsworth (1972). It seems to produce six to nine categories according to each author's notions of what can be regarded as a basic or primary emotion. Ekman et al. themselves settled for six emotion category terms plus interest, although more recently (Ekman & Friesen, 1986) a new category of contempt has been proposed. In TASS analysis, contempt could be derived from a blend of rejection with ambivalent attack and turning away in withdrawal and so would not be regarded as representing a primary emotion category. Table 6 shows the categories recognised in several major reviews of facial expression studies. It seems reasonable to say that there appear to be no more than eight commonly recognised basic or primary categories of emotion.

Dimensional analyses have been well reviewed by Dittman (1972) and Ekman, Friesen, and Ellsworth (1972) and consistently appear to identify four or five dimensions, of which three account for the major data variance. These three dimensions are commonly identified as i) pleasantness-unpleasantness, ii) activation level, and iii) interest or attention-rejection. Dittman points out that these are not too different from the original proposal of Wundt (1907) that there are three dimensions of emotion:

TABLE 5
Possible Emotional Interpretations of Dyadic Combinations of the Eight Thwarted Action States

	Attention	*Appetence*	*Aggression*	*Aversion*	*Rejection*	*Protection*	*Fatigue*	*Acceptance*
Attention	Interest							
Appetence	Love/Hope	Desire						
Aggression	Threat	Love-hate	Anger					
Aversion	Fascination	Coyness	Fear-threat	Fear				
Rejection	Revulsion	Addiction	Contempt	Horror	Disgust			
Protection	Anxiety	Shyness	Resistance	Shame/Hide	Distress	Pain		
Fatigue	Boredom	Longing	Resentment	Despair	Sadness	Suffering	Weariness	
Acceptance	Enjoyment	Delight	Triumph	Reassurance	Sulk	Resignation	Relief	Happiness

TABLE 6
Categories of Emotion Based on Facial Expression

Salzen (1981)	*Ekman et al. (1972)*	*Tomkins (1962) Izard (1971)*	*Allport (1924)*
Happiness	Happiness		Pleasure
Surprise	Surprise	Enjoyment/Joy	—
Fear	Fear	Surprise/Startle	Surprise/
		Fear/Terror	Fear
Sadness	Sadness		—
Distress	—	—	Pain/Grief
Anger	Anger	Distress/Anguish	Anger
Disgust	Disgust/	Anger/Rage	Disgust
	Contempt	Contempt/Disgust	
Interest/	Interest		Attitude
Desire		Interest/Excitement	
		Shame/Humiliation	

pleasurable-unpleasurable, arousing-subduing, and strain-relaxation. Analyses of the language of experienced emotion (Osgood, 1962; Davitz, 1969; Russell & Mehrabian, 1977) seem to result in three major dimensions comparable with those derived from facial expression/impression studies.

The category and dimension hypotheses are not mutually exclusive and a number of workers have combined them into unified models (Schlosberg, 1952, 1954; Russell, 1980). It seems reasonable to conclude that both the category and dimension interpretations reflect real characteristics of emotional expression, perception, and experience, and that any theory of emotion must account for both.

i) Categories of emotion. In principle, TASS theory implies that there could be as many emotions as there are specific thwarted action states. However, it will be evident that differently motivated behaviours share orienting and appetitive actions (seeking, orienting to, and adjusting the goal stimulus). So, differently motivated responses to thwarting may have common appetitive orienting elements. If these appetitive orientation movements form a large part of the thwarted aroused action patterns, they will be responsible for the perceived general category of emotion. Intention movements of the specific motivated consummatory behaviour may also be present and it is these that will qualify the nature of the perceived category and give the specificity or flavour of the emotion (cupboard love, sexual love, motherly love, brotherly love, etc.). Without such specific consummatory intention movements the perceiver must rely on the nature of the arousing stimulus or situation to judge the

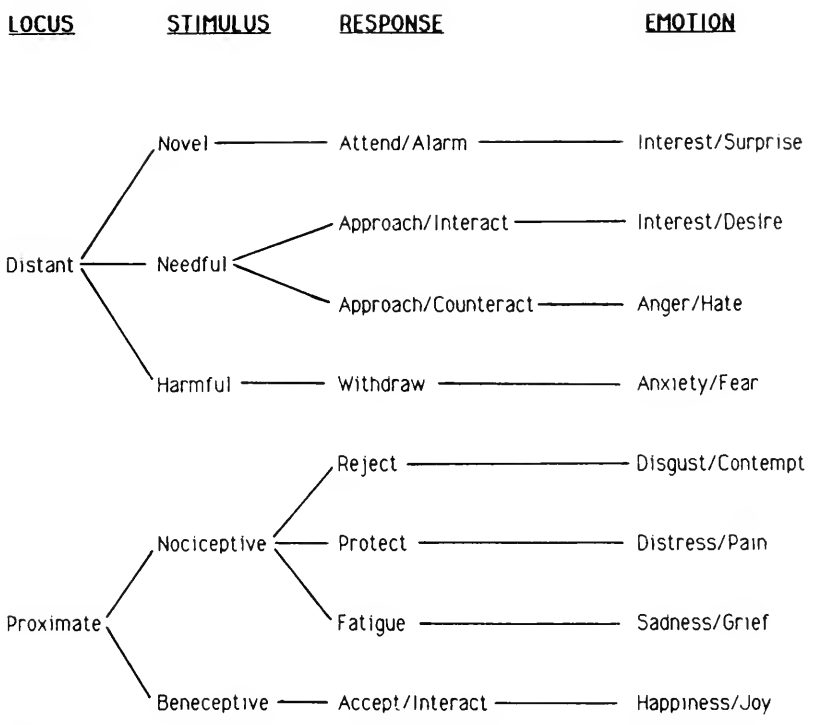

FIGURE 1. Stimulus-Response Classes and Categories of Emotion.

specific goal and motivation, and hence the likely specific quality of the emotion.

If this is true, then the general category of emotion should be specified by the general nature of the arousing stimulus and the appetitive orientation responses or intention movements that such a stimulus arouses. The possible stimulus-response classes are quite limited and are presented in Figure 1, along with the categories of emotion for which they can account. The possibilities are explained as follows.

The arousing stimulus may be either at a distance (distant) or more or less in contact with the body (proximate), and different response patterns must result. If the distant stimulus fails to arouse a specific motivated action state it can be said to be unidentified or "novel" and it evokes general patterns of arrest and attention labelled "attend" in Figure 1. If the stimulation is sudden or at high intensity this attention response may become an "alarm" display. These responses correspond with the emotion category of interest/surprise.

If the distant stimulus arouses motivated action states that require close proximity or contact for their performance then the appetitive orientation will be approach behaviour and the stimulus may be said to be "needful." This appetitive approach will be to interact in a positive

manner, i.e., to perform consummatory behaviour, and is labelled "approach/interact" in Figure 1. It corresponds with an emotion category that I have called interest/desire in Figure 1. However, approach may lead to actions that forcibly alter the arousing stimulus, either by reorienting it or changing its behaviour or its characteristics even to the point of its destruction or disappearance. This is called "approach/counteract" in Figure 1. When coupled with intention movements of the forcible counteraction (attacking, striking, biting, shaking, pushing, etc.) it is clearly seen as corresponding with the emotion category of anger/hate. This conception of anger and aggression as reorientation, readjustment, alteration, or removal of the arousing stimulus can, as previously discussed, apply to both defensive and offensive aggression.

If the distant stimulus arouses anticipatory actions of defensive, protective or pain responses, then the orientation behaviour will be aversive in the form of withdrawal from the stimulus as unwanted or potentially noxious. The stimulus is accordingly labelled "harmful" in Figure 1 and the aversive response "withdraw" includes avoidance, flight, escape and hiding. The emotion category of anxiety/fear then corresponds with the thwarting or anticipated thwarting of these withdrawal responses. As already stated there may also be tension, screams, and other protective responses in anticipation of contact with the aversive stimulus.

If the arousing stimulus is close or in contact (proximate) then it will be appropriate to either nociceptor or beneceptor systems, i.e., the stimulus may be labelled "nociceptive" or "beneceptive" (Figure 1). Nociceptor responses may initially be actions that serve to remove the noxious stimulus from the body surface and vicinity and may include visceral responses of salivation and lacrimation. These actions are labelled "reject" in Figure 1 and correspond behaviourally and perceptually with the emotion category of disgust/contempt. Strong or persistent nociception may lead to intense flexor and protective reflexes characteristic of pain. I have labelled these "protect" responses and they correspond behaviourally and perceptually with the emotion category of distress/pain. Distress screaming is the accompanying expiratory vocalization and it may have been selected and ritualized for social signalling. If nociception persists despite the reject and protect responses, then physical fatigue may become evident in a response pattern which I have labelled "fatigue" in Figure 1. Signs of physical fatigue combine with the residual thwarted specific nociceptive response patterns to give the appearance that corresponds with our perception of the emotion category of sadness/grief. Persistent failure of distant stimulus-response orientations may also lead to fatigue and the resulting hybrid patterns of loss and despair are also interpreted as sadness and grief. However, persistent proximate noxious stimulation, which can be in the form of images and thoughts, is most likely to lead to fatigue and the concomitant patterns of sadness and grief.

Finally, if the proximate stimulus operates on beneceptors, the resulting behaviour will be the cessation of appetitive or aversive orientation responses and the onset of consummatory responses and interactions. I have labelled this pattern "accept/interact" in Figure 1. It represents a transition from thwarted appetitive/aversive behaviour with high arousal, tension, and predominance of sympathetic nervous activity, to consummatory actions or quiescent resting states with declining arousal, relaxation or relief from tension, and predominance of parasympathetic nervous activity. It corresponds behaviourally and perceptually with the emotion category of happiness/joy. The explanation of the expressions of smiling and laughing as ritualized relief and relaxation responses has already been presented. The state of transition at the end of thwarting is short lived, unless re-evoked in memory, and gives place to the feelings of the consummatory actions, the consummatory stimulation and the consummated motivational state, and it is these that give specific qualities to happiness and joy and the longer lasting feelings of pleasure.

ii) Dimensions of emotion. The three "affective dimensions" of emotion commonly identified in facial expression studies are i) unpleasant/pleasant, ii) activation level, and iii) attention/rejection. There are three properties or factors of the "Thwarted Action State" that are operative according to TASS theory and that could account directly for the three dimensions of emotion as follows.

1) Thwarting/End-of-thwarting. TASS theory states that thwarting or conflict, or their cessation, must be a present or an anticipated factor in all emotional states. Obviously, therefore, thwarting and conflict correspond with the unpleasant pole and release from thwarting or resolution of conflict correspond with the pleasant pole of the "unpleasant/pleasant" dimension. The precise value along this dimension will depend on the degree and duration of thwarting, and the probability and rate of release or resolution of the thwarting as already described.

2) Level of Arousal of Action State. TASS theory requires the initial arousal or release of appetitive or aversive action states belonging to specific motivational systems. The intensity of the thwarted appetitive or aversive response patterns will be related directly to the strength of the arousing stimulus and the level of the motivational state, and so corresponds with the "activation level" dimension.

3) Stimulus-Response Valency. TASS theory suggests that responses to thwarting involve either approach to distant needful stimuli and acceptance of proximal beneceptive stimuli or withdrawal from distant harmful stimuli and rejection of proximal nociceptive stimuli. These, when combined as approach-accept and withdraw-reject tendencies, represent positive and negative response classes or a stimulus-response valency which corresponds with the emotion dimension of "attention/rejection." This affective dimension is rather less well defined in empirical studies of expression, perhaps because attention may be given to stimuli

that are being rejected as well as to stimuli that elicit approach and acceptance.

This analysis of the possible patterns of appetitive and aversive orientation and intention movements and postures in response to distant and proximal stimulation, summarised in Figure 1, when combined with thwarting and end-of-thwarting and their potential social signalling function, can indeed account for the specific eight categories and three dimensions of emotion commonly identified in studies of human facial expression.

iii) Theories of emotion. Most theories accept the existence of fundamental categories and dimensions of emotion and do not attempt to explain why they exist and why they are as they appear. Both McDougall (1936) and Plutchik (1980) account for the conventional specific categories of emotion by equating them with specific classes of instinctive or motivated behaviour, e.g., sex, parenting. Yet what is distinctive (and odd) about categories of emotion is that they apply across motivational classes. Thus, desire or love are terms that are applied to food, comfort, sex, parenting, safety, curiosity, etc. However, this apparent paradox is resolved in TASS theory by their common or shared appetitive orientation elements.

The TASS explanation of categories summarised in Figure 1 may seem comparable with Fig 11.2 in Plutchik (1980) in which, using an idea from Arnold (1960), Plutchik places his eight classes of emotional adaptive behaviours into two groups which are labelled as "approach" and "avoid" reactions to "good" or "bad" "evaluations" of a "stimulus event." The similarity is superficial. Plutchik's eight emotional response classes are ongoing, evolved directly, adaptive behaviours, while TASS theory regards them as social signalling behaviour derived from the blocking of aroused action states with general and specific information carried respectively by the appetitive and consummatory incipient actions. Nor does Plutchik make the important distinction between distant and proximate stimulus location. Furthermore, Plutchik refers to an intervening evaluation of the stimulus event by a hypothetical cognitive appraisal system, which gives rise to a subjective emotional reaction, which in turn produces the emotional behavioural reaction (cf. Fig 11.1 in Plutchik, 1980). In the present account stimuli have been distinguished according to the type of receptor/perceptual system that they trigger and the type of consummatory response that they release, so that there need be no reference to an intervening cognitive appraisal system giving a subjective emotional reaction. Instead there is a direct release by perceptual or by associative and mnemonic processes, of specific classes of motivated action systems. Finally, it is clear that according to Plutchik, emotion serves as adaptive behaviour for the individual itself. According to TASS theory, emotion serves to signal the existence and nature of thwarting in the individual so as to induce social partners to adapt their behaviour and remove the

source of thwarting, i.e., to elicit adaptive behaviour from the social partner.

The differences with other well known theories of emotion should be apparent from this comparison with Plutchik's theory. In general TASS theory differs from traditional theories that see the prime function of emotion as motivating, amplifying, directing or reinforcing the behaviour of the individual itself. TASS theory implies that only secondarily, through self-perception and the development of self-awareness, does it become possible for the individual to respond to its own emotional signals by attempting to make the behavioural changes required to achieve a resolution of the thwarting situation and hence of the emotion. This self-motivating and self-controlling function of emotion will be discussed in more detail later.

Elements of TASS theory form parts of a number of existing theories but they are assembled and employed here in a distinctive and radical manner. Perhaps the most comparable treatments of affective feelings and emotion were given by Allen (1930) and especially Paulhan (1930). The significance of incipient actions was recognised by Bekhterev (1928) who regarded emotions as "somato-mimetic reflexes." They are implicit in the "attitude theory" of Bull (1951) and in an analysis of the basis of emotional action patterns given earlier by Crile (1915). The central role of thwarting and conflict in emotion has been recognised by many theorists including Dewey (1894, 1895), Drever (1921), Howard (1928), Luria (1932), Mandler (1962, 1964, 1975) and Nunnally (1972). Leyhausen (1967) and especially Baerends (1975, 1976) have presented ethological analyses of expressive behaviour in terms of conflict states that are consistent with TASS theory. The significance of emotional behaviour for signalling and social communication is now widely recognised but not accepted as the original and primary function of emotion. In fact Darwin (1872) did not seem to recognise this (Montgomery, 1985) and Wallace Craig (1921) commented specifically on this surprising fact in a paper putting forward the signalling function. Bekhterev (1928) also noted that the somato-mimetic reflexes became "the mimical language of the animal kingdom, facilitating the exchange of reactions among various individuals." But, a theory that combines thwarting, incipient somatic actions, and social signalling requiring a social response, to provide a full biological explanation of emotion, is new. However, to complete the answers to all the questions demanded for a biological explanation (Table 1) TASS theory has to be applied to the development and experience of emotion.

THE DEVELOPMENT OF EMOTION

What are the implications of TASS theory for the development of emotion? Some illustrative answers will be attempted in the hope that specialists in developmental psychology will be encouraged to apply the

theory to the wealth of data at their disposal. In general, TASS theory implies that the range of emotional displays will increase with the development of motor patterns, motivational systems, and sources of motivational action including, of course, cognitive appraisal. Subject to motor ability, highly ritualized displays should be evident before the acquisition of cultural modulations and modifications. As coping responses to the environment and to other people's emotional displays develop, so the importance of self-signalling and self-control of thwarting circumstances and responses (i.e., emotion) should increase. The following comments may serve to indicate how TASS theory might be applied to developmental data.

i) The development of the expression of emotion. If emotional behaviour is the pattern of thwarted appetitive and consummatory actions as TASS theory asserts, then distinctive bodily emotional expressions can only be present where distinctive differentiated appetitive and consummatory behaviours have developed. Studies of whole body reactions suggest initial general excitement (Bridges, 1932) or pleasure, attention, or distress (Sroufe, 1984, Ch. 5). The neonate can show strong extensor struggling and screaming (excitement), protective flexion (distress) and relaxation and cooing (delight). With control of eye convergence, gaze, and head turning, come attention (interest and desire) and wariness/aversion (fear). Struggling develops into temper tantrums (anger). Some evidence for the role of thwarting in infant bodily expressions of emotion is provided by an old study by Blatz and Millichamp (1935) who observed infants from one month to two years of age and reported on the nature and frequency of emotional episodes which were essentially agitated states. Blatz and Millichamp drew three conclusions: i) that emotional behaviour became differentiated as different approach-withdrawal behaviour patterns developed with age; ii) that the frequency of emotional episodes decreased with age as appropriate adjustment patterns of behaviour were learned; and iii) that the causes of emotional behaviour were the thwarting of aroused approach and withdrawal states. All three conclusions are consistent with the TASS theory of emotion.

Although appetitive behaviour involving the whole body is limited in the infant, "on the face of it" the infant would seem motorically capable of fully differentiated facial actions and hence expressions. In fact there is disagreement as to the development of facial expressions in infants. There seem to be three schools of thought. i) There is a differentiation from happy and unhappy expressions in early months into fear, anger, joy, and disgust within two years, a pattern consistent with Bridges (1932) schema (Ekman & Oster, 1979; Emde, 1984). ii) Virtually all emotional expressions are recognisable in neonates or within the first few months (Field, 1982; Field & Walden, 1982). However Gaensbauer and Hiatt (1984) say that these neonate expressions are fleeting and are not reliably linked to the infant's state or behaviour. iii) Adult expression categories

are not appropriate to infant expression but specific action patterns can be reliably seen. These include the actions of crying, smiling, head aversion, pursing of lips, grimacing to taste, attention, yawning, brow knitting, laughing, flushing, panting, and weeping (Emde, Kligman, Reich, & Wade, 1978; Ekman & Oster, 1979; Charlesworth & Kreutzer, 1973).

Infant expression has previously been analysed by Peiper (1961) in terms of action patterns of regions specific to the stimulus but which tend to spread to other face regions. His response patterns include an attention response with eye opening action, a defensive grimace to taste (disgust), and respiratory responses of laughing and crying (screaming), with cying beginning as a defensive distate grimace. Studies of children born deaf-blind (Eibl-Eibesfeldt, 1973) also describe action patterns rather than emotional categories. The actions include smiling, laughing, crying, frowning, panting, refusal head shake, clenched teeth, strong exhaling, and jerking head back. Thus, in both infants and deaf-blind children the emotional displays seen to conform with the types of action that might be expected from an application of TASS theory to the development of expression (Salzen, 1981). But by two years of age children have developed the typical adult patterns of facial expression, and by five years they have learned the associations that make possible complex affective states such as shame, anxiety, elation and hope (Ekman & Oster, 1979; Charlesworth & Kreutzer, 1973; Izard, 1971, 1979).

ii) The development of perception of emotion. It is during the period of two to five years of age that accurate recognition of facial expressions in still photographs develops (Lewis & Michalson, 1985; Bullock & Russell, 1984, 1985; Russell & Bullock, 1986). But it may take longer to learn to interpret accurately the full range of adult emotional categories (Salzen, 1981). Salzen, Kostek, and Beavan (1986) compared the responses of 4–5 year old children and adults when asked to name the action and then the emotion shown in selected photographs of facial expressions. Unlike adults, children found naming the action easier than naming the emotion. Both gave action terms that fitted some of the actions hypothesised for these expressions by TASS theory. We concluded that there was some support for the view that in childhood facial action patterns are perceived and that emotional categories are attached to these patterns through learning the cultural norms. Obviously the recognition in still photographs of facial expressions is a special skill. A living model making vocalizations as well as faces is clearly going to elicit appropriate responding earlier than a silent static face photograph (Haviland & Lelwica, 1987).

In a commentary (Salzen, 1989) on a review by Oster, Daily, and Goldenthal (1989) of the processing of facial affect I suggested that in studying the development of the impression or cognitive processing of emotion the distinctions between *perception, recognition,* and *comprehension* may be useful. Correspondingly, three levels or stages of re-

sponsiveness to affective displays might be seen in the neonate, the infant, and the child respectively. Responses to affective displays in others that occur in neonates may be *innate perceptuo-motor coordinations,* while *empathy* develops in the infant and *sympathy* in children.

Perception of affect can be said to be present in the infant when different emotional expressions elicit specific motor responses or perceptuo-motor coordinations that are either innate or the result of procedural learning and memory processes (Hirsh, 1974; Cohen & Squire, 1980). An innate response might be for example distress or protective responses produced by alarm calls. The evidence of Martin and Clark (1982) that newborns respond differently to recordings of their own cries than to those of other infants suggests an innate perceptuo-motor response system of remarkable specificity. Neonatal imitation of certain parental facial contortions such as tongue protrusion (Meltzoff & Moore, 1977; Field, 1982; Field, Woodson, Greenberg, & Cohen, 1982) may also be an example of intrinsic perceptuo-motor coordination. If they included copying specific emotional facial expressions then it would be difficult to distinguish from later appearing empathic responses involving learned stimulus recognition. There is evidence that imitative tongue protrusion is lost at three months and reappears at the end of the year (Butterworth, 1990, citing a study by Vinter). This looks very like developmental shifts in behaviour such as the well known loss of the neonatal grasping reflex and the emergence of voluntary grasping, suggesting a shift from one type of neural process (often subcortical) to a neurologically "higher" one (often cortical). A similar shift in infant responses to cries from innate perceptuo-motor coordinated responses to recognition induced or empathic responding is possible.

This distinction between intrinsic matching responses and acquired recognition induced empathy is speculative but potentially useful. Recognition of affect can be said to be present when a specific stimulus expression can produce the same affective state, perhaps requiring episodic or knowledge memory processes (Tulving, 1972; Cohen & Squire, 1980) which may be associated with an experienced feeling of familiarity. Empathy, then, is the occurrence of the same emotional state as that shown by the social partner because of previous experience of the situations associated with the affective display. Comprehension can be said to exist when there are organized relationships of affective expression, situation, and consequence which together form concepts in semantic memory processes (Tulving, 1972; Warrington, 1975). Sympathy, then, is the arousal of an associated but not identical affective state through cognitive understanding of the observed affective display and a conscious act of identifying with the other person. The definitions of empathy and sympathy are given here because although they follow contemporary usage (Aronfreed, 1970; Hoffman, 1984; Miller & Eisenberg, 1988) they are the reverse of the traditional and literal meanings.

In development both empathy and sympathy can be acquired by interaction with the immediate caregivers, normally the parents, siblings and close relatives in a family-based society. Through stimulus generalization they may also occur in others of different developmental stage, mental condition, creed, or culture in an "expanding circle" (Singer, 1981). They are later generalized to neighbourhood, region, nation state and beyond. Presumably there is survival value and genetic advantage in the acquisition and application of empathy and sympathy within the family, the local group, or the state. Where this is the case it will be a factor in the development and evolution of altruism (Hoffman, 1978; Barash, 1982).

THE EXPERIENCE OF EMOTION, SELF-CONTROL AND SELF-AWARENESS

TASS theory is essentially a biological theory of the nature and evolution of emotional behaviour. If the theory represents biological reality, it should have implications for the nature, evolution, and development of the experience of emotion. The following section explores the consequences of TASS theory, especially of the signalling function, for the experience of emotion. It is recognised that this extension of the theory to cover the experience of emotion is essentially speculative and suggestive and is intended to be provocative rather than definitive.

i) Emotional experience. If TASS theory fully describes the process involved in emotional behaviour then the experience of emotion must arise from the cerebral activities associated with thwarting and end-of-thwarting states. For unpleasant emotion (thwarting) these will include i) the specific motivational state, ii) the releasing or goal stimulus, iii) the released action state, iv) the thwarting stimulus, v) the response to thwarting, and vi) the memory of previous assocations of activities i–v. For pleasant emotion (end-of-thwarting) there will be activities i–iii with the addition of vii) the stimulus effecting release of thwarting, viii) the waning of the response to thwarting(v), ix) the onset of the consummatory response and stimulus, and x) memories of previous associations of activities vii–ix. Rich and unique though these processes may be, and although they represent the emotional state itself, they cannot in themselves account for the *experience* of emotion because experience implies awareness of that emotional state. The crucial question is: what is the difference between brain processes of which we are aware and ones of which we are not aware?

The simplest explanation both in neural and behavioural terms would seem to be through "feedback" mechanisms. Neural feedback occurs at all levels, from the single neuron level to the complexes of neural activity involved in thinking, and from simple muscle feedback to interoceptive feedback of one's total behaviour. Behavioural feedback occurs through

exteroceptive perception of one's own behaviour in the same manner as the perception of the behaviour of other people. In addition there is the perception of the consequences of one's own behaviour, i.e., the "reafference" of von Holst and Mittelstaedt (1973). The integrated totality of this internal and external feedback represents the self and, in a social context, the social self. The creation of the self as an externally perceived self (which we call "me") could be through the establishment of neuronal assemblies comparable with the neuronal assemblies that represent our perceptions of other individuals so that the rest of the brain system (the "I") can interact with the "me" assemblies in the same way as it does with the representations of other individuals. It could be these interactive processes that constitute self-awareness, self-consciousness and subjective feeling. This view is consistent with the theory of the social construction of the self argued in beautiful detail by Mead (1934).

The immediate concern here is with the emotional self and with the feedback of emotional behaviour so that it is perceived (i.e., seen and heard) and processed in the brain *in the same way as the emotional displays of a social partner.* But this perception of the emotional self will be unique because it will include the interoceptive feedback which is lacking in emotional "social partner" percepts. But, if an individual responds to the affective displays of its social partners, and can perceive its own affective displays as virtually the same, then it can come to respond to its own affecxtive displays *as it might to those of another person.* This affective self, besides being part of the development of the total self, enables the development of self-control. Both self-control and self-awareness are especially dependent upon, and facilitated by, vocal displays since *these are most clearly perceived as virtually the same* in the affective displays of both self and social partners. The evolution of speech and language from such vocal displays in humans has facilitated the development of the self and the consequent possibilities for self-communication and self-control of thwarting and conflict states. This facilitation is achieved through the use of symbols for the perceived self ("me") as an object comparable with other people and other objects and for the "I" as the perceiving and acting system operating on objects, people, and myself as a person ("me").

If this picture of the self and of self-awareness of emotion is correct then we can say that *suffering* is the state aroused in us by the perception of our own unpleasant affective (thwarted action state) displays and *enjoyment* is the equivalent state for pleasant affective (end of thwarting) displays. Self-awareness, then, is not a requirement of emotion and we have no need to posit self-awareness in animals showing affective behaviour that in ourselves would involve subjective feelings or self-awareness. We can also say that such self-awareness, with its suffering and enjoyment, will occur in humans and other animals to a degree that is dependent on *the extent to which they can perceive and respond to*

their own affective displays as to those of others. This gives us an empirical and experimental approach to determining the degree of self-awareness and of suffering of which an organism is capable. Mirrors, photographs, videofilm and recorded vocalizations have been used with some success to study self-awareness in human infants and in animals. In animals there is some evidence of self-awareness of affective displays in primates and birds (Gallup, 1982; Gallup & Suarez, 1986; McArthur, 1986, 1987; Suarez & Gallup, 1987). In humans such self-awareness develops in infancy with awareness of emotional states emerging later than awareness of bodily appearance and actions (Lewis & Brooks, 1978; Lewis & Michalson, 1983).

Displays of social partners that are perceived as the same, although lacking the accompanying patterns of internal perception of our own displays, can come to evoke a comparable awareness with comparable suffering and enjoyment and this is the basis of *empathy.* In the case of *sympathy* the awareness is evoked by similarity rather than identity of the social partner's situation and affective response. A greater degree of learned cognitive processing is involved for that similarity to produce an affective response in the perceiver. The experienced affect of the perceiver reflects this and could account for the somewhat different character of the experienced affect in sympathy compared with empathy, and for the more flexible nature of the helping behaviour that may result.

ii) Self-control of emotion. Self-control of states of thwarting and conflict, and so control over one's emotional state and potentially motivational action states, becomes possible after experience of responding to the emotional behaviour and states of other people. Thus it becomes possible to respond to one's own thwarted state and behave as one might to another individual, with the possibility of doing so with acquired knowledge and experience, i.e., consciously and intelligently. In the words of Mead (1934), "The conversation of gestures is the beginning of communication. The individual comes to carry on a conversation of gestures with himself. He says something, and that calls out a certain reply in himself which makes him change what he was going to say." In this way our emotion can motivate us into coping behaviour and so control the emotion. It may, of course, simply evoke the unlearned responses so that fear evokes fear giving the runaway positive feedback of the *panic attack.*

It is the "stimulus to action" effect of "experienced emotion" that has given rise to the universal belief that emotion makes us do things, so that emotions have the function of self-motivation rather than motivation of others. Most current theories of emotion take this view. TASS theory states that the prime evolutionary function of emotional expression is to motivate and direct the actions of *social partners and not those of the individual itself,* who is already highly aroused and motivated. The thwarted action state displays of other people clearly incite us to particular types of responses, as they have evolved to do. When we perceive

our own thwarted action states they can stimulate us to make the same responses, i.e., behaviour that may remove thwarting. But the underlying motivation must be present. This point is dramatically illustrated by an account given by Oliver Sacks (1982, p. 213) of the effect of l-Dopa treatment on a post-encephalitic patient who two years previously had had a glass of water poured over her by a hostile demented fellow patient. When brought into activity by l-Dopa she wrote hostile tirades against the dement. Finally she went and threw a jug of water at the offending patient. Sacks writes "When I asked her whether she had been brooding over the matter for the entire two years, she said: 'No, of course not. I didn't care at the time. I didn't give it a thought till I started l-Dopa. And then I got mad, and couldn't stop thinking about it.' " This fits the suggestion that when there is no aroused action there is no emotion. The stimulus was there but no action to be blocked. When l-Dopa restored the "go" motor action system the remembered stimulus could produce the impulse to action and the emotion.

iii) Self-awareness. However, this external feedback or re-entry process applies to all behaviours, not just to affective displays, so there must be a continuum of self-perception and self-awareness from simple bodily actions to complex language behaviour. For heuristic purposes discrete levels of awareness of increasing complexity can be postulated as in Table 7 representing the self-perception and self-awareness of actions, feelings, emotions, and thoughts. The implication is that adult self-awareness in its global sense is a compound of these levels of self which might be expected to follow a developmental sequence beginning with the bodily self; Butterworth (1990) describes the first stage in this process. Thus the development of self-awareness of affect in infancy could pass through the stages or levels of self shown in Table 7.

This process begins with the integration and association of internal perceptions (proprio- and interoception) with external perceptions of the infant's own bodily actions in distinction from other external events, giving *motor awareness.* Since perceived comparable motor actions of social partners are not accompanied by the same internal feelings (hedonic) there arise the distinctions that comprise the *feeling self.* The same process occurs with responses to thwarting, i.e., with emotional behaviour, where the earliest and most effective external perceptual feedback comes from the infant's vocalizations (Ploog, 1979). Further cognitive development, which is greatly facilitated by but not dependent on speech, makes possible the full development of the *emotional self* capable of appreciating and responding with understanding and sympathy rather than empathy not only to the emotional states of others but also to itself. Language development facilitates the process of creating a self-concept by the labelling of oneself just as one labels others in the manner previously described and makes possible the employment of "rational" cognitive responses to the emotional displays of both other people and

TABLE 7
Levels of Self-Awareness

Level 1. Motor self.

Perception of own actions through exteroceptors creates a neural representation of the self as a real world object similar to the representations of other people and objects but distinguished by the concurrent proprioception.

Level 2. Feeling self.

Perception of motivationally significant stimuli and actions and concurrent interoception adds hedonic tone to the neural representation of the self.

Level 3. Emotional self.

Perception of own emotional behaviour patterns as similar to those of other people but with added concurrent internal states adds emotional content to the neural representation of the self.

Level 4. Cognitive self.

Perception of own speech and language as similar to those of other people facilitates cognitive interaction with the neural representation of the perceived self or "me" which may be addressed in speech and language both by other people and by the "real self" which is the whole perceiving, thinking, cognitive brain system.

oneself. This is the level of the *cognitive self* or what might be called the semantic self since it is maximal when the relationships can be mediated through language. This sequence for the development of the self parallels, and may be the basis of, the development of moral behaviour and the acquisition of socio-cultural moral attitudes (Kohlberg, 1969; Leahy & Shirk, 1985).

SUMMARY

This paper has set out to give a unified account of the phenomena of emotion and a biological explanation in terms of the thwarting and signalling of aroused action states in a "thwarted action state signalling" (TASS) theory. The behavioural phenomena are summarized in Tables 3 and 4 and Figure 1; the experiential phenomena are dealt with in Table 7. The relation between emotion and other affective processes is given in Table 2 and Table 1 shows how answers to all the questions demanded of a biological explanation have been attempted in this account of TASS theory.

An ethological analysis of social signalling is used in a comparative

approach to the nature of emotion. The somatic actions are incipient appetitive and consummatory acts that have been blocked by inadequate or inappropriate stimulus situations or by conflicting motivated action states. The locus and nature of the arousing stimulus determine the general nature of the appetitive/aversive orientation movements and give rise to the eight categories of emotion that are conventionally identified. The states of thwarting and end-of-thwarting correspond with the unpleasant/pleasant dimension of emotion; the level of the activated motivational state corresponds with the level of activation dimension of emotion; and the character of the appetitive/aversive orientation behaviour corresponds with the attention/rejection dimension commonly identified in emotion.

The thwarted somatic actions and their perceptible autonomic support actions signal the existence and nature of the thwarted motivation and serve to elicit changes in the behaviour of social partners that may alter the situation and give release from thwarting. Emotional displays have evolved for this purpose. End-of-thwarting states can become secondarily reinforcing leading to the pursuit of happiness. Other affective processes can be conceived to consist of feelings of motivationally significant sensori-motor activity, moods as states of motivational responsiveness, and sentiments as cognitive constructs with an affective content. Some indications of how the theory can be applied are given for attachment and loss, facial expression, and the development of emotional expression and perception.

The experience of emotion is derived from the external perception of one's own emotional displays as if they were those of a social partner together with the concurrent internal perceptions, which add emotional content to the self construct that has been formed by external perception of bodily action in the physical and social world. It is suggested that emotional self-perception develops in infancy and makes it possible to respond to one's own emotional states as one might to those of another person, i.e., to alter one's own thwarting and conflict situations, giving a motivating effect and the potential to exercise self-control of the emotions.

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COMMENT

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Salzen's paper is a masterful analysis of both the author's and others contributions to how bodily and facial expression might serve as social signals. As Salzen points out, Darwin, in the 1872 work, did not appear to appreciate the significance of expression to communication. The early ethological literature while, to my thinking, building on Darwin's analysis in a general way, seems not to have grasped the importance of emotional expression as a means of signalling states intentions that we think of as emotional in nature. Salzen melds emotion and ethology by arguing that emotion is a motivational state, or, at least, the squeak of its machinery. Salzen, thereby, presents the first truly evolutional theory of emotion to appear in many years.

What is strongest about this paper is that it presents a theory; not a notion, not an idea, nor even a collection of them, but a complete and testable theory that is based on our acquired knowledge and uses that information to formulate postulates and logical deductions. The theory can be tested and, like all real theories, it reinterprets and coordinates previously unrelated findings into a coherent statement.

The theory is well-grounded in the ideas of this and the last century and shows the author to have a firm and comprehensive sense of what has been said in a variety of fields. I noted valuable and important references that I worried had been lost to recent writers (Hillman, for example). Salzen's work does a splendid job of interpreting his own achievements fairly into the new model. We should hope that everyone of Salzen's stature would take the time now and then to tell us why they are doing whatever it is that they are doing and thinking, and Salzen has here provided us and the future with a detailed and engaging statement of how his work, along with that of others, of course, forms a comprehensive theory. The theory is presented, at once, as a call-to-arms, and as a clear statement of why we do what we do.

The notion of "thwarting" seems to me to come neatly and understandably from ethological models, and the notion is here so thoroughly

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worked out that one can determine how to evaluate it. I think Salzen gives credit wrongly to Plutchik by suggesting that Plutchik has an evolutionary model. It is touted as so being, but I never can find anything but lip-service being paid to how evolution is worked out. The hard analysis of how evolution works is just not there. The notion of alarm reaction I took to be Selye's, but I think this is not said. And I thought that the work of Ekman might serve more analysis than it got, chiefly because the issue he explores is so central to the signalling aspects of evolved displays, although, to be sure, I'm not sure that exploring this is why Ekman does his work. And, I think that Tinbergen's reliance on function, here repeated, is the most suspect and dangerous of explanatory principles.

The paper is far more than one more theory. It is a thoughtful and sensible contribution of major significance because it is authentic theory that is both testable and yet takes seriously what we know and have learned.

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ON THEORIES ABOUT THE NATURE OF EMOTION

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Professor Salzen presents us with his theory of emotion. At the outset of his essay he tells us two things of importance for understanding what is to follow. First, he asks, "Why add another grand theory of emotion?" His answer is that "the very multiplicity of theories suggest that none has a central point of view or a deductive or generative principle that provides a satisfactory or complete explanation of the phenomena of emotion" (p. 47). We have some difficulty with such an assertion since multiplicity of theories do not, on scientific grounds, mean none are necessarily satisfactory. An understanding of the property of light requires at least *two* theories that happen to have the feature that if one is true, the other is not. Wave and particle theories of light both serve to explain features of phenomena, and physics does quite well with multiple explanation, even contradictory ones.

The second concern we have for his reason for "yet another theory" focuses on the idea that a theory of emotion is needed *which* offers *a complete explanation of the phenomenon* (emphasis added). Any complete theory of emotion requires that we have a complete and agreed upon idea as to what defines emotion. Salzen's first requirement for a theory of emotion is that it must deal with a different set of phenomena than earlier theories have. His theoretical construction, then, of what emotion is supposed to be is not based on empirical evidence, that is, what people have meant by "emotion" over the history of thought on the subject. In any case, since the belief that a definition of emotion is available that could be agreed upon appears on its face impossible. We wonder why indeed we need yet another theory.

Our concern here is made even more acute when Salzen stated that although he was aware of them, he would not state other theories which

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are "very well known . . . nor necessary to review." We would have rested more easily with such an idea if we did not happen to notice the dates of the references given. Even though Salzen states a preference for earlier theories, the mean date of theoretical references is 1958. In fact, only approximately 35% of all the references are later than 1980! While up-to-date references may not be necessary for fields of study that moved slowly, the study of emotion and emotional development, in the last dozen years, has exploded and any theory that neglects them does so at great peril. This is equally true if the claim for the need of such a new explanation is based upon the proposition that there exists no theory yet which explains the phenomenon.

But these comments may have more to do with style of writing than with content. On the positive side, it needs to be pointed out that Professor Salzen does attempt to organize the phenomena in such a way as to provide some framework for an over all theory. For example, we think he is correct in trying to disentangle emotional experience from what have been called emotional states (Lewis & Michalson, 1983) although he prefers to call them behavior and visceral changes, and we do think his attempt to place emotion into a social context is the right way to go (Campos, Campos, & Barnett, 1989; Emde, 1988; Lewis, 1992).

We are, however, at odds with his basic idea that he calls "thwarted action state signaling" (TASS). If we understand him correctly, positive emotions are changes from thwarted action states to unthwarted ones, while negative emotions are thwarted action states. What does such a concept of emotion imply? What we come up with is an old joke which asked "Why do you bang your head against the wall?" The answer is "it feels so good when I stop!" This seems to capture the idea that positives are the absence of negatives. Such a proposition does reflect an Eastern world view, which paraphrased is something like "pleasure is the avoidance of pain." While such a view might be supported, we think it flawed for several reasons since it requires that we postulate that love, joy, etc. (positive emotions) can occur only as unthwarted negative emotions. While our language differentiation appears more discrete for the negative side of the emotional ledger, to think such emotions as joy, humor, pleasure, love, and awe as only the result of anger, sadness, fear, and shame, etc. is to deny the existence of positive emotions and relegate them to nothing more than an epiphenomenon of negative ones.

If positive emotional states are simply avoidance of negative states, then the pleasures derived from eating, for example, should always cease when the negative state (an empty stomach) is eliminated. Appetites, however, seem to be felt when there is no longer any "need"; excessive pursuit of pleasure is hardly uncommon. This suggests that pleasure seeking is an entirely different system of motivation than pain avoidance.

Sexual pleasure is no better explained by the TASS model. While the period of arousal usually does end at male orgasm, it does not often at

female orgasm, nor must arousal end in orgasm to elicit pleasure and positive emotions.

Again, if we compare two pleasurable experiences and we say one is more pleasurable than the other, this does not mean that the less pleasurable is more painful. It is easy, in common human experience, to distinguish between pain and pleasure and even pain and pleasure motivated behavior. Salzen's claim that pleasure and pain are relative motivators belonging to the same class loses the ability to distinguish between two different sets of behavioral phenomena and sensations. Emotion is experienced and exhibited in many ways that a rigid theory cannot accommodate. For example, emotion stimulating events often produce both positive and negative emotions (Lewis & Michalson, 1983). The TASS model of thwarted action cannot easily account for this.

If the idea is to find a common evolutionary root for pleasure and pain, we must keep in mind that the simplest of organisms responds to various stimuli with both positive and negative tropisms.

There are, however, even more central reasons to question this view. The first has to do with existence of pleasure centers, both in terms of physiological systems incorporating endorphins and areas of the brain distinct from its pain centers. The second has to do with cognitive systems which seem to be constructed to seek pleasure, including recent studies of emotional behavior as it interfaces with cognitive achievement.

The idea that positive affects are derived from the absence or release of negative affects parallels many theories. For example, drive reduction theories of learning argued that learning took place when a drive (or need) was satisfied. A rat learned to make its way through a maze to food because eating reduced the drive of hunger. When Harlow demonstrated that monkeys could learn to open a latch to look out, drive reduction theorists claimed that there was a drive of "looking out" or exploration. Eventually, this idea of drive reduction ceased to be held, most likely because there were too many needs or drives and the absence of any of them was not possible to prove or disprove.

Moreover, other data from new sources arose which suggested that there might exist brain regions which themselves were associated with pleasure. Olds and Milner's (1954) demonstration that rats would press a bar to receive brain stimulation suggested that there were regions of the brain which felt good to stimulate. These "pleasure areas" support the idea that positive emotions have a location which may be distinct from the negative ones. Findings also point to different brain processes and areas as well as different autonomic nervous system processes associated with positive and negative emotions (Davidson, 1992; Levenson, 1992; Levenson, Ekman, & Freisen, 1990).

More recent data on endorphins also suggest that there exist specific brain areas and receptors designed to receive and process chemical events associated with pleasure and contentment. This is to be distinguished

from chemicals and their respective receptors that inhibit pain. These findings also point to "allocated" and specific regions and processes associated with positive emotions *independent* of negative emotions. Olds and Fobes (1981) identified pleasure centers concentrated in a large tract that ascends from the midbrain to the hypothalamus. Lesions in certain areas of the dermatoses affect discrimination of texture, form, size, angle, complex patterns, movement of object, movement of limbs, relative pressure, pleasure, and temperature as well as pain (Rosenzweig & Leiman, 1982). At the moment there are little data that support the idea that reduction of activity in negative emotion regions give rise to activity in the positive emotion regions. Most neuropathological maps of the brain include different areas for the various emotions (MacLean, 1970; Papez, 1937) and the separation occurs at lower levels than the cognitive.

For us, perhaps the most important source of doubt arises from the study of infant cognitive affective behavior during a learning task. In a series of studies, M. Lewis and his associates (Alessandri, Sullivan, & Lewis, 1990; Lewis, Alessandri, & Sullivan, 1990) have observed the affective expression of infants 2- to 8-months of age as they learn a simple task. Attached to their wrist was a string that, when pulled, turned on a slide and music for 2 sec. The armpull data indicate that after an initial base period, infants' armpull rate increases significantly and reached a learning criterion of 2½ times base rate within 3–5 min. What is particularly interesting is the accompanying affective expression. Infants show *interest* faces as they initially experience the outcome as a function of their arm pull. Once past the initial experience, and as they appear to learn the connection between movement and features, they show a *surprise* expression. This appears to correspond to the "aha" or discovery phenomenon. Immediately following this, and as their armpull rate begins to increase significantly, is the *joy* expression associated with mastery. This positive expression of *joy* does not occur if infants cannot learn the connection between the arm pull and the picture/music outcome.

If at the point of learning (arm pull and joy expression) we suddenly alter the condition and introduce an extinction phase—the arm pull does not result in picture/music outcome—armpull rate increases dramatically, *joy* expressions disappear and *anger* and/or *sadness* appears. If, after 2 min, we give them control of the picture/music again, armpull rate returns to previous learning levels (2½ time base), *anger* and/or *sadness* disappear and *joy* reappears. The appearances of the positive emotion of *joy* and the negative emotion of *anger* and/or *sadness* are not related. The initial positive emotion was not preceded by or related to the negative one!

While there is much more to Professor Salzen's theory of emotions, the basic assumption of TASS makes this a highly limited and restricted account of emotions. It attempts to reduce emotions to a psychobiological model that does not fit much known data about emotion. "The logical

point is that from the fact that the behavior of a system can be *deduced* from its description . . . , it does not follow that it can be *explained* from that description" (Putnam, 1973). It certainly does not tell us much about emotional development. The task Salzen has set is an important one; nevertheless, no comprehensive theory of emotion yet exists that such a topic deserves. In the meantime, there remains much empirical work to be done.

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COMMENTARY ON "ON THE NATURE OF EMOTION"

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One of the least satisfactorily explored fields of psychology is that of motivation, and a major part of that field, social motivation, is perhaps the least understood of all. An ever present component of motivation is emotion, acting as a source of internal stimulation. Consequently, Salzen's paper, on the nature of social emotions, deals with a very important phenomenon. His paper not only presents his TASS theory in detail, but includes an extensive review of the literature on emotion from Darwin's paper up to the present.

The central part of the paper deals with a general theory of emotion which Salzen calls "Thwarted Action State Signalling" which he shortens to TASS. I shall comment on this theory in the light of my own research in two relevant areas: that of the emotional basis of attachment (Scott, 1987) and the role of emotion in agonistic behavior (Scott, 1975).

Salzen, whose primary training and research background is in ethology, which began as a descriptive science, centers his attention on observed social signals and explains these as a result of thwarted action states. This raises two immediate questions: 1) Do all emotions result in signals, i.e., are they always expressed externally; and 2) do all action states result from thwarting?

Applying the theory to the phenomena of attachment and separation, one of the principal emotions observed in infant dogs is separation distress, taking the form of vocalizations emitted at very high rates, sometimes more than 100 per minute. These can be first elicited at approximately four weeks of age, rise to peak rates at about 8–9 weeks and gradually die out as the animal grows older.

Applying Salzen's theory, the isolated puppy is thwarted in any attempt to rejoin its mother and litter mates, becomes highly aroused, and emits social signals that have the effect of attracting the attention of the animal's caretakers, either the mother or human caretakers. The observed behavior is, therefore, consistent with TASS theory.

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Once the puppy is beyond the age when, in a purely canine society it would normally not require caretakers, the symptoms of separation change. A dog separated at six months of age or older shows two types of responses. The most common is a fear response to anything strange, either living or nonliving, combined with efforts to escape and run away. This behavior in a free situation would result in a lost animal's wandering around until it found its home. The fear response would prevent it from staying in any new situation long enough to become attached there. Once taken back to its home kennel, an experimentally separated dog immediately becomes nonfearful and shortly begins to emit social signals such as tail wagging that indicate a friendly approach and a subordinate attitude.

If we analyze this behavior, the separated dog is certainly thwarted in its attempts to return home and is highly aroused or activated. To illustrate the strength of arousal I can cite the case of a six month old dog that was separated from its familiar kennel and caretakers and brought to a home. It responded by complete inactivity. The new owners reported that it would not move, eat, urinate or defecate for 24 hours, remaining totally quiet the whole time, at which point they brought it back. This dog, as well as those whose response took the form of fearful behavior, did not emit social signals but rather behavior that was adaptive to the situation: the fearful dog's attempt to run away from the situation, or in the case of the inactive dog, to escape notice. Incidentally, after a long and partially successful attempt to get it attached in a new home situation, the inactive dog eventually ran away.

The conclusion is that thwarting the attempt to return to the site to which the individual is attached will result in strong emotion in dogs of any age but will only result in social signalling if signalling will result in relief. Therefore, the theory needs some modification to account for the above behavior. Under some conditions, thwarting results in emotional arousal followed by adaptive behavior rather than social signalling. Social signalling results only if there is some possibility that it will result in some relief from thwarting.

A second kind of behavior following separation in mature dogs is somewhat closer to the Salzen model. A six-months old basenji (a breed that has a reputation of being aggressive) was adopted by a family of experienced dog owners. A few weeks later they reported that the dog had severely bitten various family members on at least three occasions, and without warning. Some of the bites were severe enough to draw blood. I and my associates verified this behavior, which most dog owners would call fear biting because it results when a person approaches a strange dog. Before we attempted to approach this dog, we carefully observed it and concluded that it was not a "happy" dog. It showed no positive interest in any person, familiar or strange, and did not wag its tail. Sure enough, when closely approached, it attempted to bite but only got hold

of loose clothing. We therefore returned it to its home kennel where it again became friendly toward people and subsequently never bit anyone. The significant fact is that while dogs have a full repertory of warning signals such as barking, growling and snarling, this dog gave none of these before it attacked. While the bite itself might be called a signal, I would be inclined to call it the behavior itself.

This brings up the question of whether Salzen's theory can be applied to aggressive behavior and if so, how. Most of my early work was done with fighting in house mice, and one of our first problems was to find out why mice fight. House mice are much less social than dogs, and one of the reasons is that fighting produces spatial separation. We found that the most reliable method of inducing fighting in a male mouse was to expose it to an attack by another male; the attacked male invariably fought back. We concluded that pain was probably the effective stimulus, as even very young mice will bite in a reflex fashion if a tail is pinched.

A common method of inducing an attack is that of isolation. An inexperienced male mouse is put into a strange cage and left 24 hours. At this point an inexperienced stranger is placed in the cage and usually starts investigating its new surroundings. The first male, which apparently has become attached to or at least habituated to the strange case, attacks in most cases. Ebert (1983) later showed that female wild mice would attack other females when placed in an isolation cage, but in a smaller proportion of cases. That is, both sexes have the same behavioral capacities, but express them in different frequency. It will also be noted that mice do not show the obvious fear responses that occur in separated dogs.

With respect to social signals, mice have some that are not directly apparent to humans, such as odorous signals and ultrasonic vocalizations. Two that are easily visible to any human observer are hair fluffing and tail rattling. These are given while a male in an isolation cage is apparently hesitating before making an attack on a stranger. These can be interpreted as warning signals. Another set of signals is given by a defeated mouse. The attacked mouse, after being severely beaten, will often assume an upright posture, hold out its forelegs stiffly, and squeak audibly when approached by the attacker. This defense posture can be interpreted as a signal that the mouse accepts defeat. It also has an inhibitory effect on the attacker, as it exposes the vulnerable parts of the body that are not usually bitten or hurt in fighting. An attacking mouse usually attempts to bite the posterior lumbar region where vital organs are well protected and where the result of a bite is a superficial wound rather than a disabling one. Applying TASS theory, one could say that a strange mouse thwarts the resident's action state (some emotion that is not obvious but is presumably related to anger), and the result is a warning signal followed by the behavior itself. In a free situation the strange

mouse would or could run away without being attacked. In this case the TASS theory applies without difficulty.

Furthermore, in some highly social and group living animals such as chickens and dogs, prolonged agonistic interaction will result in its reduction to threat by the winning animal and avoidance by the loser. Such a dominance-subordination relationship is agonistic behavior reduced to a symbolic (or signalling) form.

Unlike chickens and dogs, house mice are unable to develop good dominance orders. If they are held in contact, mice have two available relationships: 1) complete peacefulness or 2) a situation in which there is constant attacking by a male that has won fights over all the others. The losers attempt to escape but do not become subordinate nor fight with each other. The peaceful relationship can be achieved by rearing a litter of male mice together from birth to adulthood. This phenomenon is explained by the principle of passive inhibition.

Incidentally, mice do not seem to be highly disturbed by being isolated in a strange situation. Their responses are to investigate thoroughly the new area and quickly resume their normal activities of feeding and nest building. Thus, there are importance species differences in the phenomena associated with attachment.

From these examples, I conclude that thwarting (or frustration, which may be an emotion itself) does produce emotion in most if not all cases, but thwarting may either lead to social signalling on the one hand or to directly adaptive behavior on the other. Social signalling is likely to occur in highly social species and in situations in which a social signal can result in the relief of whatever produces the thwarting in the first place. The TASS theory is important, but it does have some limitations.

Another question, dating back to the James-Lange theory of emotion, is whether either a behavior or a social signal can occur in the absence of emotion. We found that agonistic behavior in highly trained fighting mice could appear in a fraction of a second, *before* the slow physiological changes that are associated with emotional states can occur. I also suspect that in a highly trained subordinate animal in a species that is capable of developing good dominance orders, signals indicating a subordinate status could eventually appear with little if any internal emotional response preceding them.

What is the relationship of TASS theory to other theories of emotion? Salzen reviews these other theories in a somewhat cursory fashion, but since this has been done very thoroughly in the volumes written by Plutchik (1980) and edited by Plutchik and Kellerman (1980) this is not a serious omission. But it is clear that Salzen intended his TASS theory to replace rather than supplement others. My own viewpoint is that because the phenomena of emotion are so complex and because they can be approached from so many directions, it is valuable to have a variety of theories.

I would also like to point out that there is a resemblance between the TASS theory and the three factor theory of maladaptive behavior that I proposed (Scott, 1988). The three factors are: 1) a prolonged state of strong motivation, usually accompanied by or including a strong emotional component; 2) inability to adapt to or respond to the motivation; and 3) inability to escape from the stimulus situation that produces the motivation. The combination of these three factors over a long period produces disorganized or maladaptive behavior. This has been demonstrated by numerous investigators in various animal species in the field of experimental neurosis. Factor one is equivalent to Salzen's "action state," and factors two and three are conditions that produce thwarting. Only the end result, maladaptive behavior, is different from Salzen's formulation. Salzen's theory assumes that the animal should signal, receive help and so escape from the situation. I see no contradiction between these two theories except that signalling behavior is not an essential part of the three factor theory.

A perennial problem is the classification of emotions. If one starts with human subjective reports of emotion, the result is several hundred different names, a situation of unmanageable complexity. Most authors have reduced these to less than a dozen groups, most of which overlap to some extent but are not identical. Salzen has reduced his list to eight, based on human facial expressions. My own preference is to classify according to the association of emotions with the ten major categories of adaptive behavioral function. Some of these such as sexual and agonistic behavior are purely social, and others such as ingestive and defensive behavior may or may not involve social interactions. Some emotions, such as hunger and anger, are associated with specific categories of behavior; others such as fear may occur in more than one category.

Comparing my list with his, Salzen has grouped the emotions related to sexual behavior into two categories, one associated with eating (he does not mention hunger as an emotion) and one with acceptance and relief. He apparently does not consider hunger as an emotion or action state. Likewise, he separates the two emotions associated with agonistic behavior, anger and fear, into separate categories.

Part of these difficulties with classification arise from the fact that, as B. E. Rosenberg (private communication) once remarked, we know a great deal about the unpleasant emotions such as fear, anger and pain, but almost nothing about the pleasant ones such as joy, love and ecstacy. Salzen proposes that the joyful, ecstatic and happy emotions are the end result of the TASS process; i.e., joy is the end result when thwarting is relieved. While this undoubtedly occurs (one has only to look at the faces of persons emerging from a public restroom), joy, satisfaction and love may also be associated with an ongoing behavior, particularly caring behavior defined as any sort of helping another, including parental care, and allelomimetic behavior, the joy of working with a group or team.

I conclude that there may be many valid classification schemes for emotion, depending on the basis for categorization and the particular aspect of emotionality which is being investigated.

Salzen's paper also illustrates one of the difficulties that psychologists have when they try to investigate phenomena that are first described in popular terms. They are forced to redefine such terms, which always leads to confusion, as the reader has to refer back continually to the new definition in order to be sure of what the author means. Emotion itself is one of these popular terms, and so are most of the descriptive terms referring to specific emotions. Salzen, in the light of his theory, has redefined the terms of affect, feelings, moods, emotion and sentiments. I regret that he chose to redefine affect, which originated as a coined term for emotion that did not carry the surplus meaning of the original. Salzen thinks of affect as an inclusive term embracing all the rest of the above and hence of little value as a tool for theory.

Finally, the importance of any theory is that it gets other scientists to raise questions that can be answered by observation and experimental tests. Reading this paper has certainly caused me to rethink many of my former ideas and to formulate the questions that I have raised above. At the same time, the phenomena associated with emotion are so complex that a great variety of theories should be useful, each attacking different aspects of the phenomena. One striking omission from Salzen's paper is a theory of individual variation, both in emotional expression and activation states. The explanation of such variation must reside in a combination of genetic, experiential and environmental factors. Salzen mentions evolutionary theory, but does not go into the genetic theory which is its basis. It takes little observation to see that humans vary a great deal in expression of their emotions and little more observation to see the variation in emotional expression among different animal species. In our experiments with the social behavior of dogs, we (Scott & Fuller, 1965) found that the highest degree of heritability among breeds was associated with physiological differences which are of course the basis of the internal phenomena of emotion. Likewise, we found important breed differences in the rate of expression of distress vocalization in isolated puppies, although all breeds and all individuals showed this reaction to some degree.

In conclusion, TASS is an important new theory of emotion dealing specifically with social signalling, which is a new way of looking at the phenomenon that Darwin called the expression of emotions.

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THWARTED ACTION AND NEED— INFORMATIONAL THEORIES OF EMOTIONS

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The Russian psychologist L. Vygotsky wrote: "The path of definition and classification followed by psychology over the course of several centuries led to the fact that of all the chapters of this science, the psychology of feeling appeared to be fruitless and tedious."

The merit of E. A. Salzen, the author of "Thwarted Action State Signalling Theory," is that much more important. He has tried to suggest a synthetic theory of emotions that integrates their psychologic, neurologic, and evolutionary-biological aspects. While reading Salzen's paper, I became convinced of the similarity of a number of its theses with my approach to the nature of emotions, elaborated by me since 1964 (Simonov, 1991).

The results of psychophysiological experiments done in 1964 brought me to the conclusion that human emotions were determined by an actual need and the estimation of the probability (possibility) of its satisfaction on the basis of phylo- and ontogenetic experience (Simonov, 1975). The individual makes this estimation involuntarily (sometimes unconsciously), comparing the information about the means and time that are predictably necessary for satisfaction of this need with the information at hand. A low probability of goal achievement leads to the negative emotions of fear, alarm, fury, grief, etc.; an increased probability of satisfaction, as compared to an earlier estimation, generates positive emotions of pleasure, joy and encouragement. Attaching great importance to the estimation of the probability of need satisfaction in the genesis of emotions, I called this concept "the need-informational theory of emotions" (Simonov, 1984).

In its most general form, the rule for the genesis of emotion may be presented as a structural formula: $E = fN(In - Ia)$, where E = emotion,

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its degree, quality and sign; N = the power and quality of the actual need in the broadest sense of the word. For human beings, it is not only hunger, thirst, sex, etc., but also social needs such as the need to belong to some group, to occupy a definite place in the group hierarchy, to have self respect, and ideal (spiritual) needs to obtain knowledge, to satisfy curiosity, to create artistically, and so forth (Simonov, 1986). (In − Ia) is the estimation of the probability (possibility) of need satisfaction on the basis of phylo- and ontogenetic experience; In = information about the means prognostically necessary for satisfaction of the need; Ia = information about the means available to the individual at a given moment. "Information" refers to its pragmatic meaning that can be determined as the change in probability of goal achievement.

In 1984, Price and Barrel confirmed our results. A study was carried out in which participants were asked to mentally conceive of any emotional episode that took place in their life or that they might create by their imagination, and then mark on special scales the strength of their wish, the suggested probability of goal achievement, and the rate of emotional feeling. Quantitative processing of the obtained data confirmed the existence of the relationship, termed the "general law of human emotions" by the authors.

The variety of needs that coexist, as a rule, and comprise complex, hierarchically organized systems, makes constructing any "complete," "detailed" classification absolutely unthinkable and hopeless. This is why most authors try to determine a limited number of basic emotions, not being satisfied with assigning them only as positive and negative. Since the probability of satisfying needs depends to a very large measure on the individual's actions, we suggest that it is precisely the character of the actions that can serve as a classifying principle for disclosing the fundamental emotions that occupy the central position in the sphere of the emotional states of humans. The interaction with the object that satisfies a need, in its turn, is either of the contact type that the individual may interrupt or continue, but not avoid; or of the remote type. As far as remote actions are concerned, according to military terminology, they exist in three basic variants: attack (surmounting), defense (protection, preservation) and retreat (loss of positions occupied earlier). Emotions corresponding to these types of interactions are presented in Table 1.

Besides the character of the actions, the origin of basic emotions may be connected with three basic groups of human need:

1. Vital (biological) needs and the material needs dictated by them: the need for food, clothing, housing, and technology necessary for producing material goods, for means of defense against harmful actions, for ensuring individual and species existence.

2. Social needs in the narrow and proper sense of the word (since all human drives are socially determined). In this case we are speaking of the need to belong to a social group (community), to occupy a specific

TABLE 1
Classification of Emotions Depending on Extent of Need, Probability of Its Being Satisfied, and Type of Action

Extent of Need	*Evaluation of Probability of its Being Satisfied*	*Contact Interaction with Object*	*Remote Action*		
			Mastery, Possession of Object	*Protection, Preservation of Object*	*Winning the Struggle for Object*
Increasing	Exceeding prediction	Delight, satisfaction	Rapture, happiness, joy	Lack of fear, boldness confidence	Triumph, inspiration, courage
Slight	High	Indifference	Tranquility	Weakening	Imperturbability
Increasing	Dropping	Dissatisfaction, aversion, suffering	Agitation, sadness, grief, despair	Caution, anxiety, fear, terror	Impatience, indignation, anger, rage, fury

place in the group, to enjoy attachments to and the attention of other members of the group, and to be an object of their attention and love. Attempts to reduce all the diverse social needs of people to a "thirst of power" are hopelessly antiquated. The need for leadership is only one of the many varieties in this group of motivations. The need to be a "follower" sometimes hides a desire to be a leader in strength and wit.

3. Ideal (spiritual, cultural) needs for knowledge in the broadest sense: knowing the surrounding world and one's place in it, knowing the sense and purpose of one's existence on earth. Without a doubt, the so-called aesthetic need belongs to this group.

The effect of ablation of the frontal neocortical areas and destruction of the hippocampus on the level of emotional stress suggests the participation of these brain structures in the estimation of the probability of need satisfaction: the probability of reinforcement. Special tests showed that for a lobectomized animal all signals became equally probable, whereas a hippocampectomized rat reacted only to signals of highly probable events. These animals started to behave like living automata without hesitation and doubt (Simonov, 1991).

Unlike the "informational" brain system (frontal neocortex and hippocampus) that estimates the possibility of need satisfaction, the "motivational" system (amygdala and hypothalamus) provides dynamic coexistence, a hierarchy of competing needs, distinguishing primary satisfaction of the dominant need. Individual characteristics of the interaction among the four brain structures form the basis of the extraversion-introversion, emotional stability, and neuroticism parameters. Disturbance of this interaction determines the formation of the main type of neurosis (Simonov & Ershov, 1991). For example, it is highly probable that a state of chronic anxiety may be due to the dysfunction of the hippocampus, in that a very broad complex of external stimuli requires nontypical signaling of vague trouble. Suppression of the amygdala-hypothalamic system function leads to depression: types of anguish, loss of desires and interests. The deficiency in the mechanisms of the frontal neocortex that hinders the inhibition of reactions to signals and their traces after these signals have lost real meaning may play a considerable role in the genesis of fixed actions and ideas.

As a single integrative complex, the four structures are necessary and sufficient for the organization of behavior in the coordinate system "needs/possibility of their satisfaction." In the living organism, needs are the most potent factors and the environment is important (i.e., significant) for the organism to the degree it can satisfy these needs. The postulation of two components in the genesis of emotional reactions, i.e., the need and the reflection (the probability of its satisfaction), neutralizes the long-standing opposition to an energetic and informational approach to studying motivational and cognitive aspects of the emotions (Simonov, 1984).

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RESPONSE TO COMMENTARIES ON "ON THE NATURE OF EMOTION"

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Candland's comments are rewarding and reinforcing. I accept his comment on Plutchik; I used "alarm reaction," perhaps improperly, for a behaviour and not for Selye's physio-behavioural stress syndrome; and I did not elaborate on Ekman's work because it does not address the questions of causation, function and origin.

Scott's general comments are also encouraging. In response to particular comments, TASS theory agrees that adaptive behaviour is indeed an alternative to signalling of thwarting because it means there is no thwarting. It is the increased orientation behaviour in thwarting situations that gives rise to adaptive behaviour. TASS also agrees that uninhibited attack is neither emotional nor a signal because it is not thwarted behaviour. It becomes emotional in the form of threat signals when it is thwarted or fails. TASS theory is not inconsistent with Scott's three-factor theory of maladaptive behaviour, but he includes emotion in his motivation factor whereas in TASS theory emotion is the behavioural outcome of blocked motivations.

Scott associates an emotion with each of his behavioural classes but TASS theory says that in principle there are no categories of emotion because the orientation behaviour depends on the motivation and the spatial relation to the stimulus object. The limited possibilities of these factors can account for the commonly recognised general categories of emotion. The specific motivation and its incipient consummatory acts given the nuance and flavour of the emotion as in love of food, child, sex partner, etc.

The Lewises are unwilling to consider any redefinition of common language terms (which Scott agrees is necessary) and they regard 'what people have meant by "emotion" over the history of thought on the subject' as empirical evidence but not the animal and human behaviour that I have used to construct TASS theory. Simple arithmetic is used to imply that I have missed recent theories and findings that invalidate or supersede TASS theory but none is specified.

The Lewises' difficulties arise from their traditionalist view of emotion

as an experience or feeling state that may be expressed in behaviour while TASS theory takes the converse (neo-Jamesian) position. Feeling state classifications and concepts can be translated into TASS theory as follows. The feelings of the orientation behaviour in thwarting are those of rising tension and effort (muscular and visceral) and may be judged unpleasant according to intensity and duration. At end-of-thwarting the feelings of the relaxation of these actions and tensions may be judged as pleasant. Thus positive emotion (pleasure of end-of-thwarting) requires the prior existence of negative emotional (unpleasant thwarted) states and *not* the *avoidance* of negative states as the Lewises seem to think. Hence the practice of teasing to enhance joy and why the old joke about head-banging is no joke to the masochist.

But responses to thwarting also include incipient consummatory acts and these add specific motivation and consummatory feelings which are judged as pleasant or unpleasant (or positive and negative) according to their appetitive or aversive nature. Love, for example, is thwarted approach for consummation and should be experienced as a complex of feelings of incipient consummatory pleasure and frustrated arousal and tension. Anticipation of success (end-of-thwarting) gives joy, and of failure (chronic thwarting) gives sadness. Hence being in love can be a mixture of joy and sadness according to the changing perceptions of love returned and love unrequited.

I have great respect for the Lewises' experimental work and am delighted that the results they describe, rather than invalidating, are fully in accordance with TASS theory. Once the infant makes intentional orientation movements to produce the stimulus, there is an aroused action state that is thwarted until the stimulus appears. At first the moment of presentation is not precisely expected and so produces the surprise orientation response. Presentation of the stimulus at the expected moment gives end-of-thwarting relaxation (joy) responses. Practice leads to anticipation of relaxation, producing the joy of mastery. End-of-thwarting joy will not occur if the orientation behaviour (arm-pull) does not produce the stimulus. Furthermore, in extinction there is, as TASS theory predicts, an increase in orientation behaviour (primary response to thwarting), angry behaviour (secondary response to thwarting), and finally sadness (fatigue of primary response to thwarting). Restoration of stimulus control by the orientation behaviour (arm-pull) means that end-of-thwarting joy will reappear. The Lewises' experiment provides a beautiful confirmation of TASS theory's predictions and I thank them for it.

Simonov's "Need-informational theory" of emotion uses psychological concepts such as "personal, social, and spiritual needs" and "information and expectations." I hesitate to interpret these accurately and faithfully into the lower level biological concepts of physiology and ethology that are used in TASS theory. I think the theories agree in postulating cau-

sation of negative and positive emotions by the respective prevention and expectation of performance of aroused motivational actions. In both theories emotion is *not* a form of motivation but is a *consequence* of motivations, and the other commentators misquote TASS theory on this point. But TASS theory does also explain the apparent motivating action of emotion through its signalling effect on the behaviour of the social partner and, through self-perception, on self-conduct. Both theories also employ contact and remote stimulus relationships to differentiate categories of emotion, but with somewhat different results.

Simonov's theory does not provide a function for emotion. Social signalling of thwarting with its function of eliciting behaviour that changes the thwarting situation is a crucial element in TASS theory. Furthermore, the theories classify motivations differently. Simonov's theory uses the psychological constructs of individual, social, and mental needs, whereas TASS uses the physiological constructs of internal and sensory homeostatic imbalances and gonadal hormone levels. The theories are, to some extent, complementary, one giving a biological basis for the other. Perhaps the two together might be more acceptable to the Lewises in view of their comment on theories of light.

Finally, there is no space to consider the comments on the neurology of emotion. Simonov's treatment has similarities to that of TASS theory, which implies that, apart from ritualized displays, there will be no specific systems for specific emotions but rather an interaction of systems for specific motivations and their consummatory acts, for general approach/aversive orientation, for behavioural inhibition, and for memory and learning. I have an extensive account in manuscript form which is seeking an understanding journal editor and referees.

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